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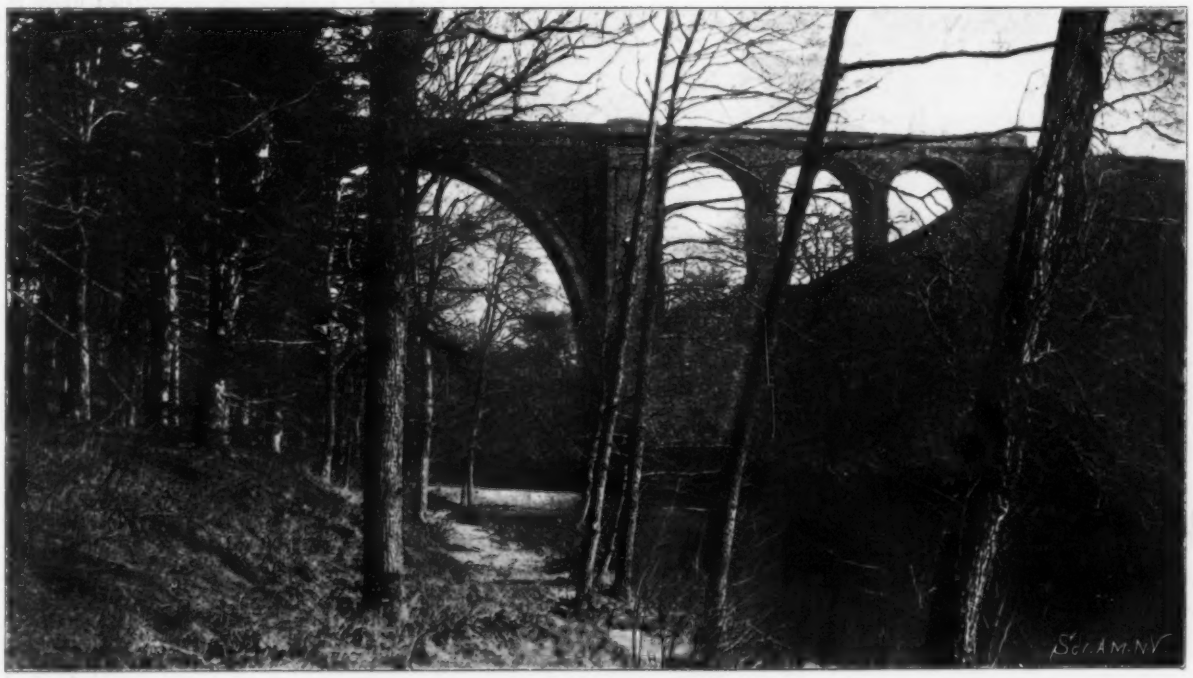
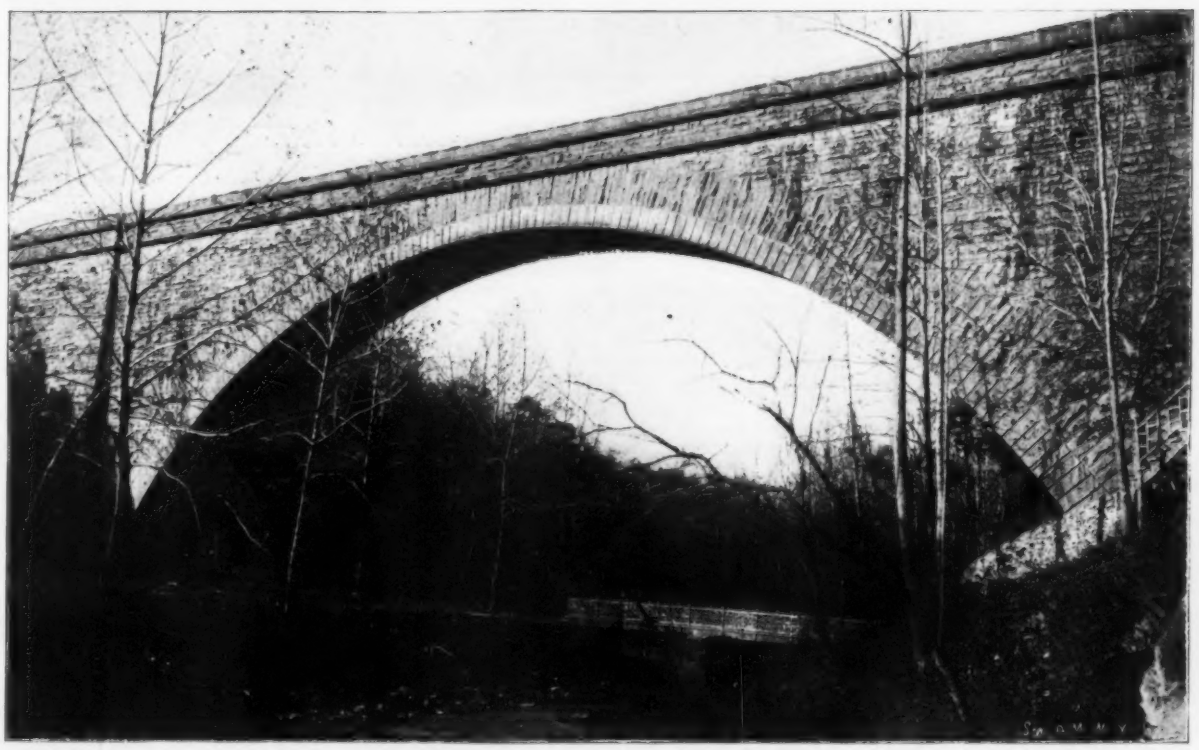


BALLOCHMYLE BRIDGE, SCOTLAND—SPAN, 180 FEET.



CABIN JOHN BRIDGE, WASHINGTON—SPAN, 220 FEET.

SOME CELEBRATED LONG-SPAN STONE ARCH BRIDGES.

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The longest single-span arch ever constructed is now being built over the Petrusse Valley, at the expense of the Grand Duchy of Luxemburg. It will probably be opened in the spring of 1903. It will have a span of 275½ feet. The roadway will be 144 2-5 feet above the Petrusse River, a small brook whose deep valley separates Luxemburg from the site of its new railway station. The arch will in reality consist of two distinct parallel bridges, 19 feet 7 inches apart, the foundations of which will be of concrete. The whole plan of construction is novel. The roadway is supported over the spandrels by four 17½-foot semicircular arches at each end, and beyond the main 275½-foot arch are two 70.8-foot arches. The total width of this bridge between the parapets will be 52½ feet. The stone, which is said to be of excellent quality, is furnished from quarries in the immediate vicinity. The materials to be used are approximately as follows: Masonry, 776,952 cubic feet; wood for scaffoldings, 28,252 cubic feet; metals (iron, zinc and cables), 45 tons. The cost will be about $270,000.

In connection with this matter it may be of general interest to note that, leaving out of consideration the bridge already alluded to, the longest one-span arch now in existence is the one known as Cabin John Bridge, near the city of Washington, which has a span of 220 feet and a rise of 57.26 feet. It was projected by Brigadier-General Montgomery C. Meigs as a part of his plan for conveying the water in pipes from the Great Falls of the Potomac to Washington. The ravine crossed by this bridge is known as "Cabin John Run," named after an old man who lived on the banks of the creek below. About six years were occupied in its construction (1857-1863). A larger one-span arch, no longer in existence, was built by order of the Duke of Milan, over the Adda, a tributary of the Po, at Trezzo in Northern Italy. It had a span of 251 feet, a rise of 88 feet and a thickness of 4 feet at the crown. It is said to have been demolished in 1427 by Carmagnola, an Italian general.

GROSVENOR BRIDGE, CHESTER, ENGLAND—SPAN, 200 FEET.

Among the large one-span bridges it may be of general interest to mention the following: Over the River Pruth in Galicia extends the Jarameze railway viaduct on the line of the Austrian Stanislau-Woronienka Railroad. This has a single arch of 213¼ feet, with a rise of 58 feet. It is built of sandstone, and is said to have cost only $40,000, on account of the low price of labor and the abundance of stone and timber in the vicinity. The Lavaur Bridge, in France, on the Limoges and Brives Railway, with a single span of 201¾ feet. The celebrated Grosvenor Bridge over the Dee at Chester, England, with a span of 200 feet, and the Ballochmyle Viaduct on the Glasgow and Southwestern Railroad, with a span of 180 feet.

ENAMELING.—I.

Enameling is an art which may claim the respect due to antiquity, although the year, or even the century, when it was first introduced is unknown. The place of its origin has never been clearly ascertained, but one thing is certain, and that is that it belongs to the East. Japan claims the honor, but from the history of China—the pioneer of so many arts in her early days of progressive industry—one is led to conclude that the Celestial Empire has a more authentic basis on which to assert her pretensions to its practical introduction. The specimens of enameled ware which are kept in museums as relics of the industry in bygone ages, show an excellence which cannot be surpassed at the present time. The colors are varied, but limited to the primaries and secondaries, generally applied to copper, and held in position by flat copper wire. This wire is arranged in the form of the design, and the interstices filled up by the various enamels. It would be out of place in these columns to write a history of the development of the enamel industry, as this series of articles is to be confined to the practical part of the industry, which, at the present moment, constitutes a monopoly held by a few firms in England and on the Continent. The secrets of the industry have been most jealously guarded, the best proof of which is that no technical institution programme includes its name, and textbooks descriptive of the process are unknown; facts to be borne in mind by the reader.

Enameling is frequently confused with lacquering, and, in many cases, the parts of bicycles said to be enameled are really lacquered. The constituents of lacquer are entirely different from those of enamel, the surface, when coated, being softer, although possessing a luster equal or even better to outward appearance. With ordinary care and attention an enameled surface is, however, infinitely more retentive of its finish; but its usefulness is confined chiefly to iron, steel, and copper, and ceramic manufacture, while lacquers—frequently called enamels—can be largely used in decorative art on woodwork. The enameling industry is divided into the following two sections, but there are several sub-divisions: (1) Artists' and jewelers' enamels; (2) commercial hollow-ware and plate enamels. The objects of the former are two-fold: (1) Artistic; (2) protection from the chemical and mechanical influences; while the latter are chiefly applied only for protective purposes. Any metal or alloy, if coated with a deposit of gold, copper, or iron, can be made to receive a coating of enamel; but this course is seldom resorted to, for the obvious reason of expense.

In these articles we will confine the subject to the large commercial enameling industry, which includes: (1) Hollow-ware enameling for domestic use; (2) hollow-ware enameling for chemical use; (3) enameling locomotive and other tubes; (4) enameling drain and water-pipes; (5) signboard enameling.

The hollow-ware enameling industry, which at one time gave promise of becoming one among the many large manufacturing interests of England, has fallen short of expectations. This can be readily accounted for. England and Englishmen, in their protection of "secrets," have long been distinguished by their conservatism, and in connection with this industry there has been no exception. The process was known to a few, and strictly guarded, and as profits were satisfactory they were content to go on without change and without any efforts to pierce into the prospects of the future. Few or no practical efforts have been made to develop the systems of manufacture in use, and that great incentive to invention and development—viz., competition—was entirely absent. Everyone can realize what England's trade would have been without competition, without scientific and technical education, and yet these are the fates which have fallen upon the manufacture of enamels. In Germany and Austria things have been managed differently. In these countries comparatively small premiums can induce manufacturers to take in intelligent apprentices, who, at the expiration of their articles, are bound to work for some years longer in return for the advantages they have received. Theoretical instruction, and to some extent practical experimental work, are to be found in a few of the technical institutes, and to this arrangement we can trace the decadence of hollow-ware enameling in England and its enormous development in the two countries named. It must not be supposed that continental enameling is superior to that of English in quality; if there is any difference it is in favor of England, but so many improvements in the mixings and in the process of the manufacture have been introduced by our neighbors, that they are in a position to undersell us by not less than 25 per cent. Of course a lower wages bill contributes its assistance toward this end; but if we put this down at 10 per cent, the balance of 15 per cent is a monument of our national carelessness.

In no part of Continental Europe is English hollow-ware to be found, in our colonies the same fact exists. If we take India as an example, we find the annual imports of that country amount to over twenty lakhs of rupees; yearly the imports are increasing, and in a short time will be more than doubled. Austrian works, financed by German capital, supply nearly the whole of this, and they claim that competition is impossible. All this goes to prove how indifferent our manufacturers have been to the improvement of an industry which might have found profitable employment for a large amount of capital and for a great number of the unemployed of our workpeople.

There is one defect to which all enamel ware is subject, and that is chipping. This may be caused by (1) imperfect mixing of the enamels; (2) imperfect fusing; (3) imperfect pickling of the iron; (4) rough usage. With ordinary care a well-enameled article has been known to last in daily use for ten or twelve years, whereas defective enameling, say, on a sign-tablet—which is exempt from rough usage—may not have a life exceeding a few months. All enameled articles, such as hollow-ware and sign-tablets, first receive a coating of a composition chiefly composed of glass called "gray," and this is followed by a deposit of "white," any additional color required being laid above the white. In the mixing and depositing of these mixtures lie the secrets of successful enameling. The "gray" has to be fused not only on but also into the metal at a bright red—almost white—heat, and it is obvious that its constituents must be arranged and proportioned to expand and contract in a somewhat uniform manner with the iron itself. The "white" has to be fused on the surface of the gray, but the gray being much harder, is not affected by the second firing. If it was liquefied it would become mixed with the white and destroy its purity. Frequently, owing to inferior chemicals, imperfect mixing or fusing, a second coating of white is necessary, in order to produce a surface of the necessary purity and luster. The difficulties of enameling are thus easily understood. Unless the metals and chemicals are so arranged and manipulated that their capacities of expansion and contraction are approximately the same, inferior work will be produced. Oxide of iron on the surface of the plates, inferior chemicals, incorrect mixings, insufficient or over-heating in the process of fusing, prevent that chemical combination which is essential to successful enameling. The coatings will be laid on and not combined, with the result that there will be inequalities in expansion and contraction which will cause the enamel to chip off immediately if submitted to anything approaching rough usage, and in a very short time if submitted to chemical or ordinary atmospheric conditions.

In England the enameling industry is now chiefly confined to the manufacture of sign tablets, which is the simplest form to which this important art is adapted. Sign-tablet enameling is, however, kept as great a secret as any other type, and many concerns which have sprung up from time to time have come to grief from want of the necessary knowledge or experience to produce satisfactory work. This branch of the industry is divided up as follows: (1) Setting the plates; (2) scaling and pickling the plates; (3) mixing the enamel constituents; (4) melting the enamel constituents; (5) grinding the enamel constituents; (6) applying the enamel; (7) drying the enamel coatings; (8) fusing the enamel on the articles; (9) lettering—including alphabetical and other drawing, spacing, and artistic art in arrangement; (10) stencil cutting on paper and stencil metal; (11) brushing; (12) refusing. In English manufactories distinctive branches of this work have distinctive experts, the arrangement being generally as follows: Nos. 1 and 2 may or may not be combined; Nos. 3 and 5 may or may not be combined; Nos. 4, 7, 8, and 12 generally combined; No. 6 generally the work of girls; Nos. 9 and 10 generally combined; No. 11 generally the work of girls and boys. The twelve processes, therefore, require six classes of trained workpeople, and incompetence or carelessness at any section can only result in imperfect plates or "wasters."

A brief superficial description of these processes will enable the reader to follow the more detailed and technical description to follow, and is, therefore, not out of place. Ordinary iron sheets will do for the manufacture of sign tablets; but a specially prepared charcoal plate can be had at a slightly increased price. The latter type is the best, for in many cases the scaling and pickling may, to a certain extent, be dispensed with. To make this article, however, as complete as possible, we shall begin from the lowest rung of the manufacturing ladder—i. e., from the first steps in the working of Lowmoor, Belgian, or other suitable iron.

I. SETTING.

The plates may be received in sheets, and cut to the required size at the enameling factory, or, what is more general, received in sizes according to specification. The former are more liable to have buckled slightly, become dented or otherwise out of truth, and

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have to be restored to a smooth and uniform surface by hammering on a flat plate. The operation seems simple, but an inexperienced operator may entirely fail to produce the desired result, and, if he does succeed, it is with the expenditure of a great amount of time. An expert setter with comparatively few and well-directed strokes brings an imperfect plate into truth and in readiness for the next operation.

II. SCALING AND PICKLING.

The annealing of the sheets in special furnaces loosens the scale, which can then be easily removed, after which immersion for some time in diluted sulphuric or muriatic acid thoroughly cleans the plate. Firing to a red heat follows, and then a generous course of scrubbing, and the last traces of acid are removed by dipping in boiling soda solution. Scouring with sand and washing in clean water may follow, and the metal has then a perfect and chemically clean surface.

III. MIXING THE ENAMEL CONSTITUENTS.

(a) Ground, foundation, or gray.—All articles, whether hollow-ware or plates, are operated upon in a very similar manner. Both require the foundation coating generally called "gray." The gray constituents vary considerably in different manufactures; but as regards the use of lead, it is universally conceded that while it may in many instances be used with advantage in the enameling of sign tablets, etc., it should under no circumstances be introduced into the coating of articles for culinary purposes, or in which acids are to be used. The first successful commercial system of enameling was only introduced into England fifty years ago—1850—and the composition of this covering was: Cullet (broken glass), carbonate of soda, and boracic acid. This composition remained constant for many years, but ultimately gave place to the following: Cullet, red lead, borax, niter. The borax and red lead form the fluxes, while the niter is to "purify" the mass. Some of the later mixings consist of the following: Silica powder, crystallized or calcium borax, white lead, fused together. This would be called a frit, and with it should be pulverized powdered silica, clay, magnesia. This recipe is one requiring a very high temperature for fusing: Silica powder, borax, fused and ground with silica, clay, magnesia. This requires a slightly lower temperature: Frit of silica powder, borax, feldspar, fused together, and then ground with clay, feldspar, and magnesia.

The approximate quantities of each constituent will be given in another article, but it must always be remembered that no hard-and-fast line can be laid down. Chemicals vary in purity, the furnaces vary in temperature, the pounding, grinding, and mixing are not always done alike, and each of these exert a certain influence on the character of the "melt." These compositions may be applied to the metal either in the form of a powder or of a liquid. Some few years ago the powder coating was in general use, but at the present time the liquid form is in favor, as it is considered easier of application, capable of giving a coating more uniform in thickness and less costly. In using the powder coating the plate is rubbed with a cloth dipped in a gum solution, and the powder then carefully dusted through a sieve over the surface. In this condition the plate is submitted to the fusing process. In using the liquid material the plate surface is dipped into or has the liquid mixing carefully poured over it, any surplus being drained off, and any parts which are not to be coated being wiped clean by a cloth. The coating is then dried in suitable stoves, after which it is ready for fusing on to the iron. The gray coating should be fairly uniform and smooth, free from holes or blisters, and thoroughly covering every part of the iron which is to be subjected to any outside influence. Cooling slowly is important. Rapid cooling frequently causes chipping of the coating, and in any case it will greatly reduce the tenacity of the connection existing between the glaze and the metal.

Generally the next surface is a white one, and it depends upon the class of article, the character of the enamels, and the efficiency of application, whether one coat or two will be required. Roughly speaking, the coating is composed of a glass to which is added oxide of tin, oxide of lead, or some other suitable opaque white chemical. The mixture must be so constituted as to fuse at a lower temperature than the foundation covering. If its temperature of fusion were the same the result would be that the gray would melt on the iron and become incorporated with the white, thus loosening the attachment of the mass to the iron and also destroying the purity of the white itself. Bone ash is sometimes used, as it becomes uniformly distributed throughout the melt, and remains in suspension instead of settling. Bone ash and oxide of lead are, however, in much less demand than oxide of tin. The lead is especially falling into disfavor, for the following reasons: First, it requires special and laborious treatment; secondly, it gives a yellowish-white color; thirdly, it cannot resist the action of acids. The following is a recipe which was in very general use for some years: Glass (cullet), powdered flint, lead, soda (crystals), niter, arsenic. Another consists of the following: Borax, glass, silica powder, oxide of tin, niter, soda, magnesia, clay. These are fused together, and when being ground a mixture of Nos. 1, 3, 7, and boracic acid is added.

Enamel mixings containing glass or china are now generally in use, although for several years the experience of manufacturers using glass was not satisfactory. Improved compositions and working now make this constituent a most useful, and, in fact, an almost essential element. The glass should be white broken glass, and as uniform in character as possible, as colored glass would impart a tinge of its own color to the mixing.

The following are two distinct glazes which do not contain glass or porcelain: Feldspar, oxide of tin, niter, soda. This is free from any poisonous body and requires no additions: Silica powder, oxide of tin, borax, soda, niter, carbonate of ammonia, or magnesia.

Alkalies.—Of the alkalies which are necessary to produce complete fusion of and combination with the quartz, soda is chiefly applied in enamel manufactures, as the fusing temperature is then lower.

Bone ash.—This material will not add opacity, but only semi-transparency to the enamel, and is therefore not much used.

Boracic acid.—Boracic acid is sometimes substituted for silicic acid, but generally about 15 per cent of the former to 85 per cent of the latter is added. Borax as a flux is, however, much easier to use, and is therefore largely used in enamel factories.

Borax.—Calcined boax, that is, borax from which a large proportion of the natural moisture has been eliminated, is best for enamel purposes. It is a flux that melts at medium heat, and enters into the formation of the vitreous basis. Borax has also the property of thoroughly distributing oxide colors in the enamels.

China.—See porcelain.

China clay.—See clay.

Clay.—Only a fairly pure clay can be used in enamel mixings, and the varieties of clay available are therefore limited. The two best are pipe—or white—clay and china clay—kaolin. The latter is purer than the former, and in addition to acting as a flux, it is used to increase the viscosity of mixings, and therefore the opacity. It is used in much the same way as oxide of tin.

Cryolite.—Ground cryolite is a white mineral, easily fusible, and sometimes used in enamel mixings. It is closely associated with aluminium.

Cullet.—This is the general material used as a basis. Clear glass only should be introduced; and as the compositions of glass vary greatly, small experimental frits should always be made to arrive at the correct quantity to be added.

Decolorant materials.—See niter, red lead, and manganese.

Feldspar.—The introduction of feldspar into an enamel frit increases consistency. The common white variety is generally used, and its preliminary treatment by pounding is similar to that adopted with quartz.

Flint.—See silicic acid.

Fluor-spar.—In this mineral we have another flux, which fuses at a red heat.

Fluxes.—These are for the purpose of regulating the temperature of fusion of a mixing—frit—some being better adapted for this purpose than others. This, however, is not the only consideration, for the character of the flux depends upon the composition or chemical changes to which the ingredients are to be subjected. The fluxes are borax, clays, cullet, porcelain, feldspar, gypsum, and fluor-spar.

Glass.—Glass is composed of lime, silicic acid, and soda or potash. The use of the glass is to form the hard, crystal-like foundation. See cullet.

Gypsum.—This mineral is sometimes used in conjunction with baryta and fluor-spar.

Kaolin.—See clay.

Lead.—Crystallized carbonate of lead, or "lead white," is frequently used in enamels when a low temperature for fusion is required. It should never be used on articles to be submitted to chemical action, or for culinary use. Minium is a specially-prepared oxide of lead, and suitable for enameling purposes, but is expensive.

Lime is in the form of carbonate of calcium when used.

Magnesia, carbonate of, is only used in small quantities in enamel mixings. It necessitates a higher temperature for fusion, but does not affect the color to the slightest extent if pure.

Manganese.—As a decolorant, this mineral is very powerful, and therefore only small quantities must be used. Purity of the mineral is essential—i. e., it should contain from 95 to 98 per cent of binoxide of manganese.

Niter.—At a certain temperature niter shows a chemical change, which, when affected by some of the other constituents, assists in the formation of the vitreous base.

Opacity.—See oxide of tin, bone ash.

Oxide of calcium.—See lime.

Oxide of lead.—See lead.

Oxide of tin.—All enamels must contain white ingredients to produce opacity, and the most generally used is oxide of tin. By itself it cannot be fused, but with proper manipulation it becomes diffused throughout the enamel mass. On the quantity added depends the denseness or degree of opacity imparted to the enamel.

Porcelain.—Broken uncolored porcelain is sometimes used in enamel manufacture. Its composition: Quartz, china clay, and feldspar. It increases viscosity.

Quartz.—See silicic acid.

Rock crystal.—See silicic acid.

Red lead.—This discolorant—sometimes called purifier. It will, however, interfere with certain coloring media, and when this is the case its use should at once be discontinued.

Silicic acid.—Quartz, sand, rock crystal, and flint stone, are all forms of this acid in crystallized form. By itself it is practically infusible, but it can be incorporated with other materials to form mixings requiring varying temperatures for fusion.

Soda.—The soda in general use is carbonate of soda—58 per cent—or enameling soda. The latter is specially prepared, so as to free it almost entirely from iron, and admit of the production of a pure white enamel when such is required. See also alkalies.

NOVEL POWER STORAGE.

An interesting little story was told some time ago of some one in the practically waterless parts of Western America, where there is barely sufficient water for drinking purposes, who proposed to drive, or was actually driving, a number of arrastras by sand, the latter turning a large overshot wheel, taking the place of water. The intention was at first to run the arrastras by means of a large windmill, but the uncertainty of this power finally led to the adoption of the plan mentioned. A windmill still was to form part of the scheme, but it was to run a conveyer to carry the sand up to a large elevated tank. From this the sand was to be eventually allowed to run out upon the overshot wheel, causing it to revolve just as it would under the weight of a stream of water, and the sand tank had sufficient storage capacity to insure continuous running of the plant. There the tale ended, though a few more particulars of the right kind would have given it a more likely coloring.—Cassier's Magazine.

GENERAL SPECIFICATIONS FOR A GASOLINE MOTOR CAR.

By H. WARD LEONARD, Bronxville, N. Y.

1. THE relation between the horse power of the motor and the weight of the car with tanks full shall be such that there will be not more than 200 pounds weight per brake horse power of the motor.

2. The motor shall be placed forward in such a manner that its weight will be carried upon springs over the front axle; exposed to good air circulation; free from dust and mud; readily accessible; and so that any vibration due to the motor will not be objectionably felt by the passengers.

3. There shall be a spring-actuated cone friction-clutch between the motor and the driving mechanism which can be opened by a pedal, so as to quickly disconnect the motor in the most simple and positive manner whenever this is desirable, and so that the power must be applied in a gradual manner to accelerate the car without detrimental shocks or strains. This cone friction-clutch shall be so placed as to be readily inspected and shall be provided with simple means for quickly adjusting the tension of the spring which forces the frictional surfaces into contact.

4. There shall be a pedal-operated foot-brake sufficiently powerful to readily hold the loaded car upon a 20 per cent grade either ascending or descending. This brake shall be so arranged that it will cause the friction-clutch to be opened before the foot-brake is applied. This foot-brake shall be applied upon the main driving shaft between the motor and the differential so as to avoid all tendency to skidding. This foot-brake shall be metal upon metal and shall be readily and promptly adjustable.

5. There shall be a very powerful hand-operated brake which will simultaneously apply two band-brakes upon the hubs of the back wheels. These band-brakes shall be readily and positively adjustable, so that they can be adjusted to act exactly alike and thus avoid all tendency to skidding when this powerful brake is suddenly applied. This brake shall be made so that the operator's hand can be removed after the brake is applied without releasing the brake, thus making it possible to apply a strong brake and yet have the operator's hands free for other purposes. This brake shall be so placed that in applying it the operator does not have to move his body and thereby disturb his steering while he is applying the brake.

6. There shall be three principal forward speeds and one reverse speed. The reverse speed shall have a much greater reduction than any forward speed so as to reduce the risk due to backing the car in a bad place. All three forward speeds shall be controlled by a single lever which shall be mounted upon the steering column, so that the variable gear can be quickly and readily operated without affecting the steering. When the high-speed gear is in use there shall be no gear wheels of the variable speed gear in motion so that the noise, wear and loss of power due to the use of gears shall be avoided during all usual operation of the car upon the level and upon moderate grades. The low-speed gear shall give a reduction sufficient to enable the car carrying its operator to readily ascend a grade of 20 per cent upon a good macadam road. Under such conditions the friction-clutch shall not heat due to slipping.

7. The steering shall be by means of an inclined wheel with a sufficient reduction to be irreversible in ordinary operation. There shall be no lost motion in the steering mechanism. The steering mechanism shall be wholly above the level of the bottom of the axle so as to be as well protected as possible from being struck by obstacles in the road. All levers and joints in the steering mechanism shall be so placed as to be always in plain view and readily accessible, so that any defect in the steering mechanism will be immediately apparent. The steering mechanism shall be so designed that the car can be turned in a 22-foot circle, thus making it possible to turn the car in any ordinary road without using the reverse gear.

8. In order to secure the greatest stability the height of the operator's seat above the road shall not exceed 42 inches. The length of wheel base for all cars capable of making thirty miles per hour shall not be less than 62 inches. The gage of the wheels shall not be less than 46 inches.

9. For all cars weighing over 800 pounds (with tanks full) the tires shall be at least 3 inches in diameter.

10. A pump shall be placed so as to be readily manipulated by the operator while the car is in motion and which will enable the operator to positively oil the engine cylinder while driving the car at full speed.

11. The motor, variable gear and transmission mechanism shall be so inclosed as not to be affected by mud, dust or water and shall be run in a bath of oil.

12. The gasoline tank, water tank, etc., shall have capacity to operate the car for 125 miles without a stop upon good roads of moderate grades.

13. The water circulation shall be sufficiently efficient so that the car can be operated at full speed upon the lowest gear for 30 minutes without the water boiling, the water being at normal temperature at the beginning of the test.

14. The gasoline tank shall be placed in plain view in a readily accessible position so that any leak will be immediately detected.

15. The car shall be capable of making a maximum speed of thirty miles per hour on a good level road, a speed of thirteen miles per hour up a 6 per cent grade and a speed of six miles per hour up a 15 per cent grade.

16. The lever for manipulating the variable-speed gear shall be so arranged that it is impossible to manipulate the variable-speed mechanism except while the friction-clutch is open, thus making the manipulation of the variable speed gear entirely "fool-proof" and also making it impossible to suddenly apply the momentum of the motor to the car, it being always necessary to apply the power through the friction-clutch in a gradual manner, thus protecting all mechanism from

abusive strains due to inexperienced or improper manipulation.

17. The rolling friction on a hard level floor shall not exceed 20 pounds per 1,000. That is, a steady pull of 20 pounds applied by a spring balance shall keep in motion a 1,000 pound car on a level floor when the engine is disconnected from the driving mechanism.

18. All nuts which it is important to prevent from working loose shall be secured by means of efficient split pins.

19. The starting crank shall be so placed and so geared to the motor that the motor can be easily started with but slight manual effort.

20. The consumption of gasoline shall not exceed 1 pound of gasoline for each horse power hour of work, measured by brake test of the motor.

THE PRAT PRESSURE TRANSFORMER.

THE efficiency of steam engines is, despite the numerous improvements of which they have been the object, still very feeble if we consider the quantity of heat converted into utilizable work in comparison with that produced in the furnace. Among the causes that set themselves up in opposition to such efficiency, one of the most important is due to the large number of heat units that escape through the chimney. As the gases of combustion make their exit at a temperature of about 300 deg. C., there results a loss which may be estimated at about a sixth of the heat disengaged by the furnace. On another hand, the present steam engines are daily becoming more powerful and are consuming very great quantities of steam. The consequence is a large output of coal, and therefore an energetic heating that necessitates a very powerful draught.

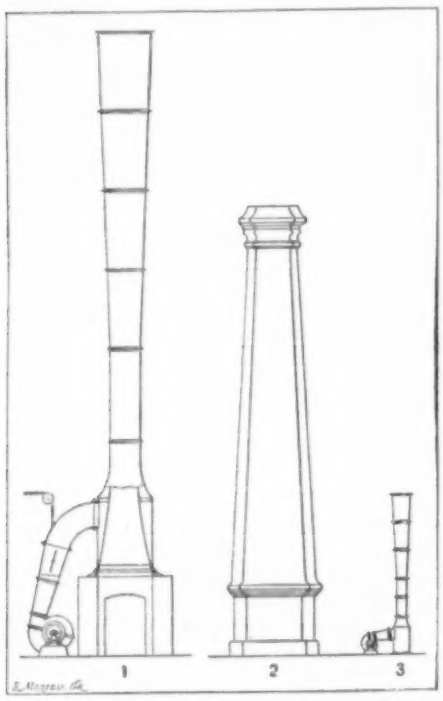


FIG. 1.—1. SECTION OF A PRAT PRESSURE TRANSFORMER. 2 AND 3. MASONRY CHIMNEY AND PRAT TRANSFORMER OF THE SAME POWER.

Now, it is well known that a natural draught is produced by the depression resulting from the difference of weight between the column of the hot gases contained in the interior of the chimney and that of the column of air that surrounds it. But, in order to increase the draught, it is necessary to increase such difference, and this can be done in two ways only, viz., by raising the temperature of the exhaust gas or increasing the size of the chimney. As an endeavor is made, on the contrary, to lower as much as possible the temperature of the gases that escape into the atmosphere by recuperating a portion of the heat carried along by means of economizers or of feed water reheaters, it will be seen that the use of a natural draught leads to the construction of taller and taller and consequently costlier and costlier chimneys.

An endeavor has also been made to replace such draught by more economical processes. Various systems have been proposed to this effect, such as: injection of steam or air under pressure into the ash-pan; suction of the burned gases by means of ventilators; and, finally, the blowing of steam or compressed air into the chimney.

It is to this last system, called "draught by entrainment," that belongs the new process of forced draught devised by M. Louis Prat, engineer of arts and manufactures. This consists in sending into a special apparatus called a pressure transformer, a current of air under pressure projected by a blowing machine. Through its flow this current produces an artificial draught which sucks up the burned gases and sends them into the atmosphere. This apparatus may be placed in the interior of any chimney for increasing the draught of it, or else may be mounted directly upon the principal flue in which the gases of combustion collect. In the latter case, it performs the function of a chimney.

The blowing machine is a centrifugal one, with a turbine of large diameter and blades of not very wide surface. As it is arranged outside of the circuit of the gases of combustion, it is not subject to oxidation by sulphurous acid or fouling by soot. The object of the pressure transformer, as its name indicates, is to lower the pressure of the fluid that supplies it. It consists of the following parts: (1) a base containing an aperture for the entrance of the air; (2) a diffusion chamber for the injected air of sufficient length to render the diffusion complete, say three or four times the size of its diameter; (3) a divergent ajutage forming a diffuser, the height of which is equal to about seven times its smallest diameter. The base itself is divided into three parts. At the lower part there is a chamber serving to direct the sucked-in gases to the expansion chamber, and upon this is superposed a convergent receptacle in such a way as to leave between the two an annular space into which penetrates the injected air. Finally, the two chambers are surrounded by a jacket that communicates with the generator of injected air and the lower part of which carries the angle iron that attaches it to the masonry.

This arrangement permits of obtaining a double diffusion due to the use of the diffusion chamber, properly so called, and of the diffuser. Finally, it is well to add that the blowing machine is connected with the pressure transformer through a wind conduit provided with a regulating valve so as to permit of reducing the work according to the extent of the draught that is desirable. The injection of the air may be central instead of annular when such an arrangement is more convenient. But, at any event, it is well to remark that the transformer is provided with no apparatus for regulating its various parts, which are so calculated and arranged that the best utilization of the injected air and a reduction to a minimum of the different causes capable of interfering with the flow of the gas of combustion may be obtained.

M. Prat's apparatus is of easy construction and its dimensions are very limited as compared with those of a chimney of equal power. This may be seen from an inspection of Fig. 1, which shows, alongside of a 49-foot transformer, a 148-foot chimney that it replaced for the service of a 1,200 horse power battery of boilers at the spinning mill of the Société Pouyer-Quertier at Rouen. Fig. 2 shows a transformer installed at the new works that the Compagnie Générale des Omnibus has constructed at Billancourt for the production of compressed air by means of sixteen generators, with economizers capable of burning, as a whole, 13,200 pounds of coal an hour. At the other extremity of the building there is a large masonry chimney 197 feet in height, which is found to be of less power, despite its greater size, since when an endeavor is made to operate the two chimneys together for the battery of boilers, its draught progressively diminishes and is finally reduced to zero.

It will perhaps be objected that this system, like all systems of mechanical draught, absorbs a certain quantity of work for actuating the blowing machine. Such work, however, is very feeble and perfectly insignificant as compared with the results obtained and the saving effected in the expenses of the establishment. The motive power necessary is in fact, in general, 0.7 per cent of that furnished by the boilers, and, at Billancourt in particular, reaches hardly 35 horse power for a disposable 6,000 horse power. On another hand, it results from some comparative experiments made at the Penhoet Works by the engineers of the Compagnie Générale Transatlantique with a marine boiler, a 21-foot high transformer and a 75-foot chimney with natural draught, that the production of vaporized water per pound of coal burned passes from 17 to 18.75 pounds, say an increase of about ten per cent, and the quantity of water vaporized per hour from 2,435 to 2,816 pounds.—For the above particulars and the engravings we are indebted to La Nature.

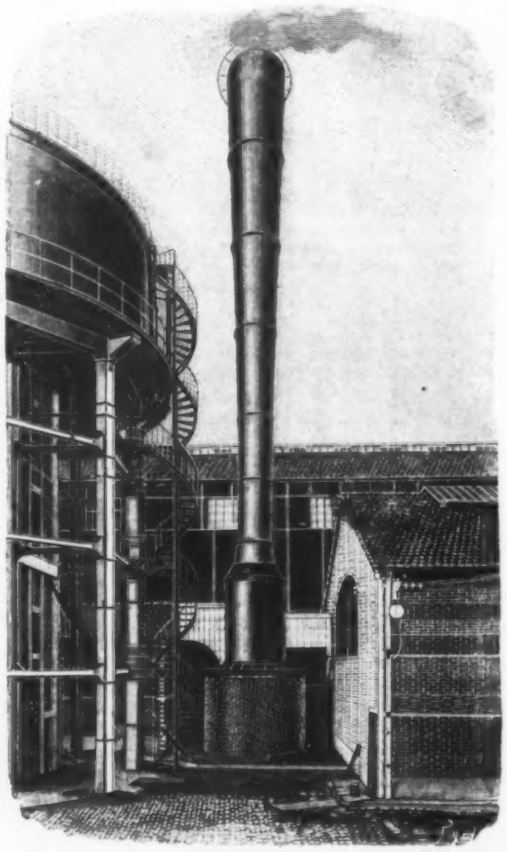
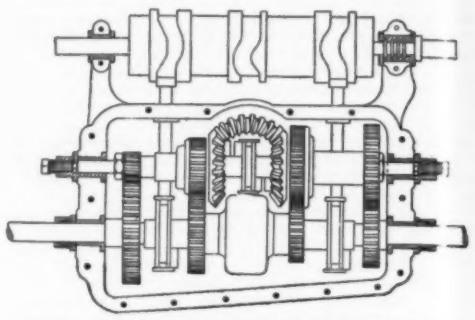


FIG. 2.—PRAT TRANSFORMER INSTALLED AT THE BILLANCOURT COMPRESSED AIR WORKS.

THE HERING VARIABLE SPEED GEAR.

THE accompanying drawing shows a new variable speed gear constructed by Messrs. Friedrich Hering, of Gera, Germany, which is being introduced into this country by Messrs. Philipp & Company, of 20 Dashwood House, New Broad Street, London, E. C. The gear is of the permanent mesh type, and is adapted to give four changes of speed and reverse motion. The changes are effected noiselessly and entirely without shock by means of a system of levers actuating friction cones, motion to the levers being transmitted by a series of grooved cams cut from the solid on an auxiliary shaft. The various changes of speed as well as the reverse motion are controlled by one lever or wheel, which actuates the cam shaft. All the gears are cut from solid steel forgings, and are inclosed in an oil-containing aluminium case. It will be noticed from the drawing that the shaft on which the driven pinions are mounted also carries the differential gear, the shaft being designed to transmit the power by chains to the rear road wheels of the car to which the gear is fitted.—The Motor Car Journal.



THE HERING VARIABLE SPEED GEAR.

THE HORSE POWER OF GAS ENGINES.

THE following suggestions, communicated to The Practical Engineer, deserve the attentive and careful study of all who are in any way interested in the construction or operation of gas engines:

We are glad to notice a growing tendency among makers of gas engines to adopt a more uniform and common-sense system of defining the powers of the motors they put on the market. In the early days of the gas engine we were accustomed to see engines described as of such and such a "nominal horse power," and even now this term, which is completely devoid of any useful meaning, is still to be found in the trade catalogues of some few makers. The process of reasoning by which the term "nominal horse power" was evolved is to most people a hidden mystery, and it is perhaps as well that it should forever remain wrapped in obscurity. The complete absurdity of the use of this expression is shown when a catalogue tells us that a certain gas engine is of, say, 8 nominal horse, and that it is capable of developing 15 actual horse power.

The "horse power" of any motor is an expression of the rate at which the motor is capable of performing work. A person who wants to purchase a gas engine knows within a little time the nature of the work the engine will have to do, and in most cases a fairly definite idea as to the quantity of this work. For instance, he may wish to drive a dynamo, which the maker tells him will absorb 15 horse power. In setting out to buy his engine, this power required to drive his dynamo is a definite point from which to start, and he enters into negotiations for the purchase of a gas engine which is to be capable of giving out 15 horse power (or a little over, to allow for emergencies). If the engine maker can guarantee that the engine which he offers will yield 15 horse power, there is no further difficulty, and if the guarantee is fulfilled the purchaser is satisfied with the smallest engine which will do this work satisfactorily. Fortunately, it is becoming the common practice among the gas-engine makers to discard "nominal horse powers" and to make a practice of testing their engines on the brake, and to give the exact output of power which their engines are capable of. The estimation of the brake horse power of a small power gas engine is not a difficult process, and the apparatus required is inexpensive and simple.

For such a case as we have suggested the use of the brake horse power is the most satisfactory way of defining the possibilities of the engine. But it has the disadvantage that it cannot be so easily applied in the case of engines of large powers. When the power of an engine exceeds 30 or 40 horse power the friction brake required becomes cumbersome and difficult to manage. What, then, is to be done in the larger sizes, which are at the present time greatly on the increase? Some engine builders make use of a form of Froude's hydraulic brake for testing engines of a large power; but this brake is a costly one, and the complete equipment of a large works with a set of these in the testing shop for dealing with engines of greatly varying powers, would involve a large outlay of money. If the engine is to be used to drive electric machinery, it may be sufficient to specify that the engine is capable of giving a certain output, as determined by the readings of the ammeter and voltmeter; but this takes no account of the efficiency of the dynamo, and does not provide a measure of the work given out by the engine, so that the only thing left is to fall back on the indicated horse power of the engine.

The line of continuity between the small power and large power gas engines is thus broken, circumstances rendering it more convenient to measure the brake horse power of small engines, and the indicated or the electrical horse power of the large sizes, and for this reason it is difficult to fully compare the performances

of small gas engines with those of larger engines, whose power is defined on a different basis.

It is a great pity that something cannot be done to remove the present unsatisfactory state of things by which the performances of gas engines are defined in so many different ways. The Institution of Civil Engineers, a year or two ago, made a very laudable attempt to place the question of the heat efficiency of steam engines on a more satisfactory basis; but we are afraid that the suggested method of definition laid down in the report on this subject, issued by the institution, has not been so generally adopted as it deserves to be. There is no reason why some such action should not be taken in regard to gas engines. The adoption of a uniform system of measurement, and expression of efficiencies, might possibly at first involve makers in a good deal of trouble, but we are sure that in the long run the benefits would be great.

Let us look at the matter more in detail. A gas engine is a heat motor, in which a certain quantity of heat, developed by the combustion of the charge of gas and air, is converted into useful work, which can be made use of outside the engine. A certain amount of work is done upon the piston of the engine, and the remainder of the heat, which has not been converted into work, is allowed to go to waste. In very few cases is this waste heat contained in the exhaust gases put to any practical use. That a good deal more might be done in this direction is shown by the fact that one or two installations have been put down with successful results, and there seems to be no reason why this lost heat should not be utilized for heating or steam-raising purposes.

Of the work done by the expanding gases on the piston only a portion is available for external use. The actual amount of this may vary from 75 to 85 per cent, in some cases getting a little higher than this. The rate at which the work is done by the gases on the piston represents the indicated horse power, while the rate at which the actual useful work is given out is called the brake or effective horse power.

When the engine is used to drive a dynamo the amperes of the current, multiplied by the volts at which the current is being generated, and divided by the number 746, gives another value, generally called the electrical horse power. This, again, is less than the effective horse power by the losses in transmission and in the dynamo, which may amount to 10 per cent, and this, added to the frictional losses in the engine, about 15 to 25 per cent, makes up the difference between the indicated horse power and the electrical horse power.

So that, putting aside the nominal horse power as being obsolete and useless, we have to deal with three different kinds of horse power, any one of which may be used to indicate the energy given out by a gas engine. Of these the indicated horse power can be found for any size of engine; the brake horse power can, as a rule, only be conveniently found in the case of the smaller sizes; while the electrical variety does not provide a satisfactory means of comparison, because the losses in the dynamo are not always shown.

Therefore it would appear that for purposes of comparing the performance of gas engines of all sizes, the only general basis is that of the indicated horse power, particularly when comparisons of gas consumption have to be made. Now the indicated horse power of a gas engine is found in the usual way, by taking diagrams and noting the number of explosions per minute, and making the necessary computation from these data. It is, however, less easy to calculate the indicated horse power in the case of a gas engine than for a steam engine. The reason of this is not far to seek. In a steam engine, running with a steady load, whether this is the full load or a very light one, the indicator cards are, approximately speaking, repeated at every cycle, and the indicated horse power calculated from one particular card is not likely to be very far from the average for the adjacent five or ten minutes. With a gas engine this is unfortunately not so. When the engine is running at full load, and this load is steady, the form and size of the indicator card are sensibly repeated at every cycle; when, however, the load is light or fluctuating, successive indicator cards show considerable variations, and these differences are most noticeable where the effect of the governing arrangement is to vary the strength of the explosive mixture from time to time. In such a case, if the indicator pencil is held on the drum for ten cycles, it will be seen that there are ten different curves drawn on the card, each one representing a different horse power. The only really correct thing to do in this case is to hold the pencil on the drum for a definite number of cycles, say ten, and to ascertain the mean speed of revolution of the engine during this time.

This is a somewhat tedious and laborious process, but it is the only accurate way, and it is useless to reckon the indicated horse power on a measurement taken from a single diagram. When taking these diagrams the number of times the pencil has traced a closed curve should be perfectly counted, because it frequently happens that two curves become superposed, and are in this case liable to be taken as one, and an error introduced. So that the indicated horse power of the gas engine is not such a very certain thing after all.

Next comes the question of gas consumption. This is generally taken as the means of comparing the heat efficiencies of gas engines of different sizes and by different makers. The consumption is generally given as so many cubic feet of gas used in one hour for each horse power developed. As the mechanical efficiency may vary in different engines—that is to say, there may be a greater discrepancy between the indicated and effective horse powers of these—the only really safe basis for comparison of heat efficiencies is to be found in the indicated horse power. It has been pointed out that this is not possible to determine with exactness, unless very great care is used, but the taking of indicator diagrams has other uses than to determine the indicated horse power, such as the setting of the valves, and it is therefore desirable that indicator diagrams be taken whenever possible. So that we will assume that the indicated horse power is accurately found. The gas consumption is measured by a meter, and it is most important when doing this to measure the temperature and pressure of the gas as it goes to the engine. The reason for this is that, in order to compare engines working under different conditions, it is desirable that the gas used shall be in each case given as so many cubic feet at the standard pressure and temperature, those used being 32 deg. Fah., and the standard atmospheric pressure at 14.7 pounds per square inch.

Having got a reasonably accurate indicated horse power, and the consumption of the gas at the uniform pressure and temperature, there is still another source of uncertainty. The gas used in different towns varies as regards its heat-giving possibilities. Thus in one town the number of thermal units given out by the complete combustion of one cubic foot of gas at the standard pressure and temperature may be 625, whereas in some other place, or in the same place at another time, this value may be 675, a difference of over 8 per cent, which would make a comparison of two engines tested with these different gases inaccurate to the same extent. It would appear, then, that the only really accurate method of comparing the heat efficiencies of gas engines on a sound basis is to ascertain the calorific value of the gas, and then to give the consumption as so many British thermal units per indicated horse per hour; or to reduce the work done on the piston to heat units, and to express the efficiency as the ratio of the heat utilized for conversion into useful work to the heat supplied in the gas.

Of course this method takes no account of the work lost in friction, and therefore is of less use to the purchaser, who is only in the first place anxious about the power the engine will give out; but it is always possible to make determinations of the effective horse power in the case of small gas engines, and to quote those in addition to the other figures, while for large engines in most cases the mechanical efficiency is not less than 80 per cent, and rarely greater than 85 per cent, so that if the indicated horse power is known the brake horse power can be found to within 5 per cent, or nearly so. It is to be hoped that a more definite and uniform basis of comparison will be adopted now that the gas engine is being so very largely used both for large and small powers.

THE "BOREAS" AIR COMPRESSOR.

THE "Boreas" air compressor exhibited at Glasgow by Messrs. Lacy, Hulbert & Co., of 25 Victoria Street, S. W., is of the two-stage type, an "intercooler" being provided on the base of the machine, through which the air is passed on its way to the high-pressure from the low-pressure cylinder. The heat generated by the initial stage of compression is given up in the "intercooler," and as a consequence the work to be expended on the second and final compression is substantially diminished.

As our engravings show, one cylinder only is employed, the first stage of compression being effected above the piston, and the second below it in the annular space between the large trunk shown and the cylinder wall. Both the cylinder and its cover are water-jacketed. The main inlet valves, which are placed in the cover, have a very small clearance. They are all identical, and, being made of steel, are very light, and thus work with little noise or wear. The intercooler consists of a system of steel tubing immersed in water, contained in a tank formed in the base of the machine, and this tank also acts as a reservoir for the water circulated through the cylinder jackets. The discharge valves for both sides of the piston, as well as the inlet valves for the lower side of the same, are contained in boxes quite distinct from the cylinder proper, and are readily accessible for inspection and renewal. The crank is lubricated on the splash system, being, as will be seen, completely inclosed. Other working surfaces are kept oiled by means of a system of forced lubrication, worked by a small valveless pump, driven from one end of the crankshaft. This draws oil from a well in the casing through a filter, and delivers it to the different bearings. Suitable oil-catchers return the oil to the well for use again.

The machine is fitted with automatic regulating gear, consisting of a "pneumatic switch," adjusted for any desired pressure, which, when this pressure is reached on the receiver, turns the air discharged from below the piston back into the low-pressure cylinder above it. The air is then simply circulated through the machine, no work being done save that necessary to overcome frictional resistances. This plan leads to very close regulation of the pressure in the receiver, since but small differences of pressure suffice to actuate the switch; and, as the compressor is kept running, no time is lost in recharging the receiver when the pressure in it tends to fall.—We are indebted to London Engineering for the engravings and description.

Fig. 1.

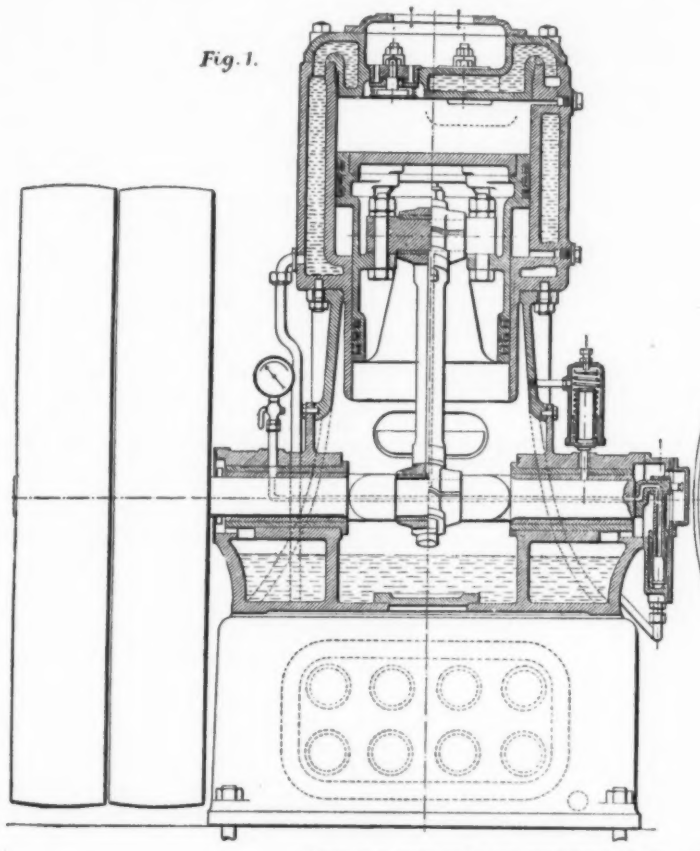
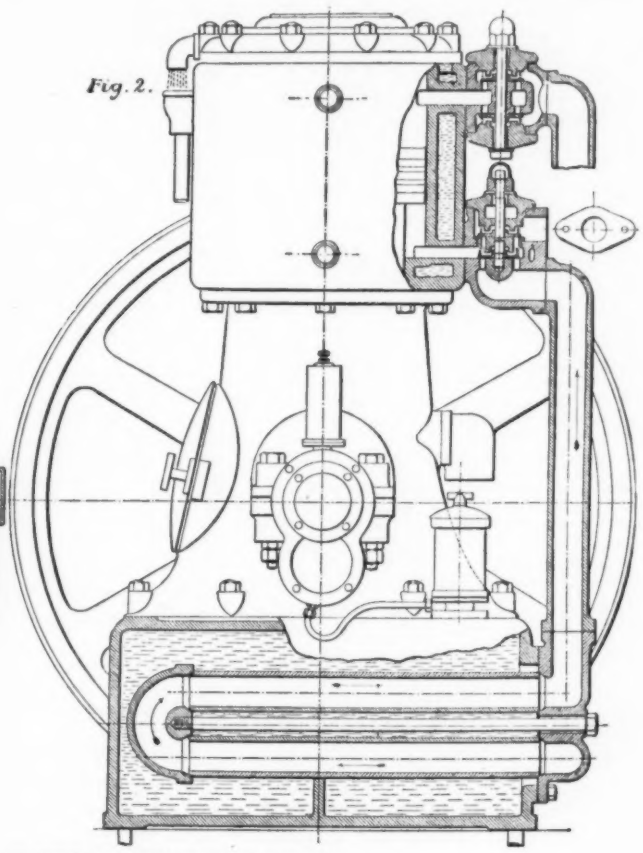


Fig. 2.



THE "BOREAS" AIR COMPRESSOR AT THE GLASGOW EXHIBITION.

It is asserted that the number of compound locomotives in use in this country (as compared with simple engines) averages 75 per cent of the whole number in use in freight and passenger traffic.

PETROLEUM FROM THE BEAUMONT, TEXAS, FIELD.*

BY CLIFFORD RICHARDSON AND E. C. WALLACE.

THE Lucas or Beaumont well, and the several others, seven or eight in number, which have been brought in since the first strike, are situated about two miles from the Neches River, the eastern boundary of Jefferson County, Texas. This county lies on the Gulf of Mexico at the southeastern corner of the State, and adjoining Louisiana, from which it is separated in part by the river and in part by Sabine Lake. From Port Arthur, a railroad and shipping terminus on the latter, the well is distant between 13 and 14 miles, while the town of Beaumont is a little more than three miles to the northwest.

Two pipe lines will connect the oil field with Port Arthur, and others perhaps later with Sabine Pass and with New Orleans, 278 miles to the east. The new field is about 200 miles to the southeast of the well-known Corsicana field in Navarro County, and only 20 miles from the Sour Lake oil region of Jefferson County, the oils from which were described in this journal for February, 1900.

The Beaumont wells lie in the coastal plain of the Gulf of Mexico, which extends back from the coast about 100 miles, and the oil is found in tertiary strata at a depth of about 1,100 feet.

According to Prof. J. C. White (Pet. Indust. and Tech. Rev., 4, 394, April 27, 1901) the initial output of the Lucas well was 10,000 barrels per day, but it increased to 70,000. How long this will be maintained is a question which the future alone can answer.

What the extent of the new field may prove to be is uncertain. It has been suggested that the entire area extending over the 200 miles between Beaumont and Corsicana may be oil-bearing; but the oils at present obtained at the two points are quite different, the latter consisting predominantly of paraffin hydrocarbons with some paraffin scale in the highest distillates, while the former is largely, if not entirely, a polymethylene oil. A well recently sunk in the Sour Lake field, and deeper than those hitherto bored at that point, 820 feet, is reported as yielding 500 barrels per day. The field may, therefore, be assumed to extend as far as this point, although whether wells at that locality will be permanent is, of course, not known.

Mr. Robert T. Hill, of the United States Geological Survey, has made an investigation of the field and has given the following preliminary report of his conclusions:

"The importance of this oil field is far greater than at present can be described or estimated. It means not only a cheap fuel supply to the largest State in area in the Union, but owing to its proximity to tide-water it promises an export trade such as exists nowhere else in the world. Preparations are being made to sink hundreds of wells, and very soon the present output of 500,000 barrels a day may be quadrupled.

"It is certainly within the limit of probability that oil will be found at many places throughout the coastal prairie, especially in its southern extension toward the Rio Grande and the northeastern State of Mexico at Tamalipas. The outcrop of the tertiary formations in southwest Texas, in Wilson, Atascosa, McMullen, Duval, and other counties, is naturally rich in oil, and practical oil men are experimenting in that region. As the oil-bearing tertiary strata extend east of the Mississippi into Mississippi and Alabama, it is not beyond probability that oil may be found in these States.

"It is impossible now to state exactly the extent of the oil-yielding bed which supplies the Beaumont well, and this can only be determined by drilling experiments.

"The area of profitable exploitation of the Beaumont oil fields is confined between San Jacinto and the Sabine rivers, east of the Houston and West Texas Railroad, and south of Oil City, Nacogdoches County. This area may be extended or restricted by future exploitation.

"It is very probable that other oil fields may be discovered in the coastal plain between the Beaumont and Tampico fields. Here lies a vast territory underlain by the oil-bearing Eocene formations which has not been exploited."

The Beaumont petroleum, being of tertiary occurrence, is, therefore, of great interest to compare with other tertiary oils, such as those from California.

Specimens of the Beaumont oil were received from the original Lucas well, taken in January and again in March, 1901. They were examined according to methods which may be outlined as follows:

Specific gravity, flash point, refractive index were determined, the first in a picnometer at 25 deg. C., the second in a New York State oil tester, and the third with an Abbé refractometer at 25 deg. C.

Viscosity.—The figures represent the number of seconds which were required for the oils to flow from a 100 c.c. pipette, according to the Pennsylvania Railroad specifications. The results are only relative.

Sulphur was determined by Carius' method.

Volatility in an Open Dish.—When 20 grammes of crude petroleum are heated in a dish, 2½ inches in diameter and 1¼ inches deep, to various temperatures for various lengths of time, or until the loss becomes small enough to neglect in any period of heating, results are obtained which are of interest, especially when compared with well-known oils. The volatilization under these circumstances goes on below the boiling point, and, the vapor not being confined, there is no cracking. The amount volatilized will, of course, be somewhat influenced by the size of the oven and number of determinations made in it at one time. The determinations were made under very uniform conditions, but are to be considered as of only relative value.

Distillation in Engler's Flasks.—This was carried out according to Engler's directions (Petroleum, Redwood, p. 502), the distillate between 150 deg. and 300 deg. C. being representative of the burning oil available commercially. Duplicate determinations by this process were very concordant. The distillate of burning oil was treated with enough strong sulphuric acid of specific gravity 1.84 to produce an oil as nearly water-white as possible. The quantity necessary for the purpose and the amount of the oil removed by the acid were determined.

Fractional Distillation.—For this purpose about a half liter of oil is distilled in a liter flask, of Engler's shape, but larger. The flask is supported on a six-mesh iron cloth and surrounded with an oven built up of loose bricks, and covered with an asbestos board. The distillate is condensed in an air condenser three feet long, connected with a Bruhl's receiver, in which a vacuum of 20 mm. can be maintained. All the joints are mercury-sealed, or of solid glass, to avoid access of air, which would induce decomposition. A current of carbon dioxide is conducted to the bottom of the distilling flask to agitate the oil and remove air from the apparatus. The oil is heated by a ring flame Fletcher burner, and distilled at ordinary pressure as long as there are no signs of cracking. As soon as any decomposition is recognized, or the temperature has reached a high figure, the oil is cooled and the vacuum made. The difference in boiling point at atmospheric pressure and at 20 mm. for hydrocarbons, boiling under 760 mm. at about 320 deg. C., is 117 deg., a distillate coming over at 317 deg. at atmospheric pressure beginning to distill at 200 deg. in a vacuum of 20 mm. For lower boiling hydrocarbons the difference is less, 92 deg. for an oil boiling at 148 deg. C. in air. The specific gravity and refractive index of the original distillates were taken at about 25 deg. C. They were then treated twice with an excess of sulphuric acid, washed with dilute soda, dried over sodium, and the determinations repeated. Finally, one of the distillates was treated with a mixture of equal volumes of sulphuric and nitric acid, washed, boiled with sodium, and examined. Ordinarily, in distillates of low boiling point, this would remove aromatic hydrocarbons, but in the case of the polymethylenes of high boiling point, such as occur in Texas oil, the acid combines with and removes a different class of hydrocarbons with the formation of an amorphous resin-like nitro derivative.

Examination of Residues.—The residues left after evaporation in the open dish, or from either of the methods of distillation are characteristic and of value in determining the nature of any petroleum, and as to whether it has a so-called asphaltic or paraffin base; that is to say, whether it consists largely of cyclic polymethylenes or paraffin hydrocarbons. Mere inspection will often reveal the presence of paraffin, while in other cases the residue is plainly asphaltic. In such cases the soft residue or pitch, as it may be, is examined further, more particularly in respect to the fixed carbon which it contains, its solubility and specific gravity. These determinations are of great relative value, as will appear later, at least if the distillation or evaporation has not been carried so far that the residue consists largely of coke.

Ultimate Analyses.—These were made with the precautions which have been found necessary in burning the polymethylene hydrocarbons, which very readily escape complete combustion.

A similar but softer pitch, made by boiling the crude oil for 20 hours in an open dish, had the following properties, as compared with a D grade residue or paving asphalt from Los Angeles oil:

——	Beaumont.	California.
Penetration	78°	78°
Specific gravity	0·9043	0·9064
Bitumen soluble in 88° naphtha	78·3	74·4
" " 62° "	84·3	81·6
Fixed carbon	8·7	15·0

Fractional Distillation.

—	Fractions.		Distilled.	Specific Gravity, 25° C.	Refractive Index, 20° C.
	° F.	° C.	Per Cent.		
Atmos. pres.	360—401	149—205	1·0	0·8114	1·459
" "	401—441	205—227	8·4	0·8408	1·461
" "	441—480	227—249	4·4	0·8509	1·467
" "	480—520	249—271	10·8	0·8705	1·476
" "	520—559	271—293	10·8	0·8863	1·485
" "	559—602	293—317	13·1	0·9009	1·492
20 mm. "	302—464	200—240	13·0	0·9184	1·505
" "	464—536	240—280	8·8	0·9349	1·514
" "	536—608	280—320	10·6	0·9429	1·521
	Total		80·9		

Residue, heavy; slow flow at 70° F.
Difference in boiling point for 760 and 25 mm. pressure, 117° C.

Effect of Reagents on Distillates.

Fractions.	Removed.	Specific Gravity after Treatment.	Refractive Index, 20° C.
	Excess of strong H_2SO_4.		
° F.	Per Cent.		
401—441	7·7	0·8367	1·463
480—520	17·8	0·8497	1·474
559—602	21·6	0·8929	1·486
	Excess of H_2SO_4 + HNO_3 after H_2SO_4.		
559—602	11·6	0·8879	1·483
	Total Oil removed by Reagents, 39·6		

EXAMINATION OF THE PRECEDING RESULTS.

From the results it appears, although the two specimens are slightly different in their specific gravity and flash points, that the Beaumont oil has a very high density for one beginning to distill at 110 deg. C., and that the hydrocarbons of which it is composed, as shown by the ultimate composition of the original oil, and by a comparison of the specific gravity and refractive indices of the 150 deg. to 300 deg. C. distillates from the Engler flasks with similar distillates from Eastern oils, must belong largely or entirely to some series other than the paraffin, and probably to the same series as those found in the Sour Lake petroleum, which we have previously examined, rather than those of the Corsicana oil, which consists largely of paraffins. It is also plain that the oil contains a much larger proportion of unsaturated hydrocarbons removable by sulphuric acid than either Pennsylvania or Ohio petroleum. The Beaumont oil has a high sulphur content and carries, as it comes from the wells, a large amount of hydrogen sulphide in solution. This gas has previously been observed in solution in petroleum, but not in so large quantity as at Beaumont. The sulphureted hydrogen is largely lost on standing and more completely on blowing air through it. After such treatment the oil contained 1.75 per cent of sulphur in the form of sulphur derivatives of the hydrocarbons. Mabery has found 2.16 per cent, but, apparently without removal of the gas. From an industrial point of view, the former figure is the one of importance to the refiner, but the latter, if the oil is to be used for fuel. This amount of sulphur, it has been inferred by some authorities, would make it impossible to use the petroleum for fuel, but many coals with less fuel value contain as much sulphur, and are used for steaming purposes without serious difficulties being encountered.

FUEL VALUE OF THE OIL.

A comparison of the ultimate compositions of the Texas oil with other oils used for fuel shows that while not equal to Pennsylvania and Ohio oils, owing to the low carbon and high sulphur, it is not inferior to the California petroleums in any marked degree.

POSSIBILITIES OF REFINING THE OIL.

Distilled in an Engler flask, the Texas oil begins to boil at 110 deg. C., but only 2.5 per cent goes over below 150 deg., as compared with 21 per cent volatilized under similar conditions in Pennsylvania, and 23 per cent in Noble County, Ohio, oil. It contains, therefore, little or no naphtha.

Between 150 deg. and 300 deg. C. 40 per cent of the oil goes over, this fraction being ordinarily considered, in the case of Pennsylvania oils, as suitable for an illuminant. As large a percentage of the oil is found in this fraction as occurs in the average run of the Pennsylvania pipe line deliveries. Its gravity is, however, quite different, 0.8749, as compared with 0.7984; it contains much sulphur and a large amount of unsaturated hydrocarbons, so that attempts to refine it with sulphuric acid necessitated the use of an impossibly large amount of this reagent and a great loss of oil. The resulting illuminating oil is not water white, and colors on standing. A better oil can be made by cutting out the distillate above 260 deg. C.

If the oil is distilled in vacuo and the same fraction, 150 deg. to 300 deg. C., is treated with an excess of sulphuric acid, a water-white product is obtained, but it is evident such a treatment is not possible commercially. In fact, unless a new process of handling this oil is developed, it cannot be made to yield a satisfactory illuminant, even were it found possible to invent a lamp and wick to burn the product satisfactorily. It would not be safe to say, however, that the Beaumont oil could not be refined under any circumstances, so as to give a good burning oil, because, although this was thought to be impossible in the eighties with the Lima, Ohio, oil, Frasch invented a process which enabled the Standard Oil Company to remove the sulphur from the distillates and to turn out an illuminating oil equal to the best Pennsylvania. It is highly probable, however, judging from analogy, that no such process is possible with the Texas oil, since no success has been attained in obtaining a first-class illuminant from California oils of similar constitution, all the product turned out being now mixed with Eastern oil, to make it passable and marketable.

The dicyclic polymethylenes burn with a very yellow and smoky flame.

RESIDUUM FROM BEAUMONT OILS.

The Beaumont oil, heated to various temperatures in an open dish, does not differ essentially from Pennsylvania and Ohio petroleum in the amount volatilized after long periods of time, or until there is no further loss. After seven hours' heating the oil loses much less at 110 deg. C., owing to the absence of any large amount of naphtha.

The greatest difference between Pennsylvania and Ohio oils and that found in Texas is in the character of the residue, which in the latter case resembles more that left by the California oils, whereas the former leaves a residue containing paraffin scale, and without the stickiness which enables the latter to be pulled out into threads.

The final residue, after heating to 400 deg. F., is in both cases a solid, but that from the Eastern oils is a brittle pitch with 45 per cent of fixed carbon and coke, while the Texas oil resembles in some respects an asphalt, although if it were strongly heated this becomes a pitch also. In fact, the products of and residues from the distillation or volatilization of these oils are much affected in character by variations in the conditions under which they are made.

The nearest approach to an asphalt was produced by boiling down the crude oil in an open kettle until it was of the consistence of California asphaltic residues, and solid enough to be handled without sticking to the fingers badly. A comparison of the properties of this material with the California product showed, however, that it was not as truly asphaltic, as the fixed carbon which it yielded was less than two-thirds as large as it should be for a true asphalt.

The Beaumont oil can hardly be called asphaltic, in so far as furnishing a commercial supply of asphalt is concerned, both because of the small amount of residue it leaves on evaporation, only about 6 per cent, and on account of the character of this residue. In this respect it resembles Sour Lake oil.

DISTILLATION IN VACUO.

Distillation of one of the samples, with the aid of a vacuum, at that point where boiling ceased to go on without cracking, gave distillates better suited for examination as to the character of the hydrocarbons which make up the oil than those from the Engler flask. Comparison of the distillates from Corsicana, Sour Lake, and California oils, given in this journal, with those from the Texas oil of the same boiling point, shows that the Beaumont petroleum is mor-

* Paper read before the Society of Chemical Industry, New York Section.—From the Journal of the Society.

closely related, as would be expected, to the Sour Lake than to the other oils.

On treatment of these distillates several times with excess of strong sulphuric acid, washing with soda and drying, it was found that the loss due to the presence of unsaturated hydrocarbons and other constituents removable by the acid, was large. The fraction, boiling between 205 deg. and 227 deg. C., lost 7.7 per cent, while that boiling between 293 deg. and 317 deg. C., lost 21.6. A very considerable part of the hydrocarbons in the Texas oils are, therefore, of an unsaturated nature.

After the removal of these hydrocarbons with sulphuric acid, a mixture of equal volumes of sulphuric and nitric acids acts quite strongly on the fraction collected between 293 deg. and 317 deg. C., removing an additional 11 per cent. The substances thus acted on are probably of a series, the hydrocarbons of which, as shown by Markownikoff, although saturated, contain tertiary carbon atoms readily attacked in the cold by nitric acid. These hydrocarbons are found in Russian and California oils and in the asphalts.

Mabery (J. Amer. Chem. Soc., 23, 265) has found for his fractions distilling between 155 deg. to 160 deg. C. at 14 mm. a similar composition, 86.25 per cent carbon, 13.48 per cent hydrogen. He, of course, properly assumes that, as these hydrocarbons are saturated and as the anaylses show that they belong to the $C_n H_{2n-2}$ series, they must be dicyclic polymethylenes, as suggested by Markownikoff (Annalen, 301, 159) for similar hydrocarbons in Russian oils and by us (On the Nature and Origin of Asphalt, Long Island City, 1898) for the constitution of the lighter hydrocarbons of Trinidad Lake asphalt. In fact, the asphalt hydrocarbons distilling at about the same temperature as those from the Beaumont oils have a similar specific gravity, index of refraction, molecular weight, and ultimate composition.

The same series of hydrocarbons evidently occurs in all these oils. They are saturated and not easily oxidized, but on heating are readily condensed to more complicated molecules, and are at the same time in part cracked.

CONCLUSIONS.

The petroleum from the Jefferson County, Texas, field is, therefore, valuable and available as a safe and desirable fuel oil, notwithstanding its relatively high percentage of sulphur.

Owing to the fact that the oil contains such a large proportion of unsaturated hydrocarbons and their sulphur derivatives, and that the saturated hydrocarbons, if refined without regard to cost, are dicyclic polymethylenes which do not prove satisfactory for illuminants, as is known from experience with California petroleum, it is not probable that Texas oil can ever prove to be available otherwise than as fuel.

PRODUCTION OF PAINTS IN ANCIENT TIMES.*

AT a time when the spirit of art is extending its sway, when esthetic taste, more vigorous and intelligent, is drawing us toward the conception of a higher artistic ideal, it may be useful to seek for a new system in making paints, a formula which will allow of obtaining a new unchangeable product, assuring the almost indefinite preservation of the colors.

In order to arrive at a solution of the problem without undertaking useless efforts the ancient methods may be studied and compared with those now in use.

What are we to understand by ancient paints? We do not make an absolute distinction between the different artistic epochs. We give this general name to all of the products which have promoted the preservation of works of art and which were employed by the pioneers or by those marvelous painters of the Renaissance, whose pictures and frescoes serve us yet as models for our modern artists.

The ancients applied on their walls three kinds of painting: fresco, encaustic with the brush or *cestrum*, and the varnish distemper.

Fresco painting consists essentially in applying on the last coat of mortar, while this coat is still soft, colors prepared in water and mingled with a little lime. The coloring matter penetrates the mortar and hardens with it.

The experiments of Regueno have reconstituted the process of painting known under the name of encaustic with the brush.

The wax and colors are mingled with resinous matters, which the authors of the time designate under the generic name of *pharmaca*. These substances are in reality: (1) sarcocol, (2) solid bitumen, (3) mastic, or frankincense.

The wax which these paintings contained played the same rôle as lime in frescoes; that is, it promoted the penetration.

The method of operation was this: the wall designed to receive the painting was first smeared with a coating of oil, then with a second coating of Greek pitch, mastic or frankincense. These substances were made to penetrate into the plaster by passing over their surface a lighted torch. Then a priming was laid which was formed of a mixture of wax and of a coloring substance, ordinarily white. The artist executed his work with colors ground in water, and mixed with wax and resins. The painting was covered with a varnish generally made of pure wax, mastic and liquid bitumen; he could not thus obtain a brilliant surface.

Finally, the surfaces were softened with the aid of heat, until they were moist on the outside. On cooling, they thickened, and became incorporated with the wall; whence the general name of encaustic.

M. Charles Henry, an authority on this subject, has shown that encaustic painting, properly so called, was perhaps rarely applied with the brush, but rather with metal instruments having the form of the betomy and the spatula, and having the technical name of *cestrum*, and the generic name of *cauteria*. The implements of the painter comprised also a box of colors and colored waxes, and a furnace for melting these waxes. Traces of *cestra* are found on the monuments.

From this process are derived three others, which resemble painting with oil, of which we will notice the origin further on: (1) Painting warm with sticks of colored wax and resin softened by the addition of an oil, then melted and modeled with the *cestrum*. (2) Painting cold with sticks of colored resin and wax, softened by the addition of an oil laid directly on the surface; then worked with the *cestrum*. (3) Painting with the brush, cold, with sticks of colored wax and resin dissolved in an essential and volatile oil.

Distemper painting was in reality an imperfect encaustic. The colors were fixed by trituration with an emulsion of glutin and the whole covered with a varnish containing a little oil, various resins and wax. It seems also that the fresco process with lime for mural paintings was in existence at that time.

In order to combat a common error, I will state that the mosaic was never a painting. It was produced by a collection of crystals, colored or gilded by ordinary processes, and was used to cover uncolored glass, in order that it might appear more brilliant.

These ancient modes were very different from the present practice. Modern painters make a great mistake in considering the forming of the first material as beneath their notice, and of using any product provided that they can with its aid produce immediately the ephemeral tint desired.

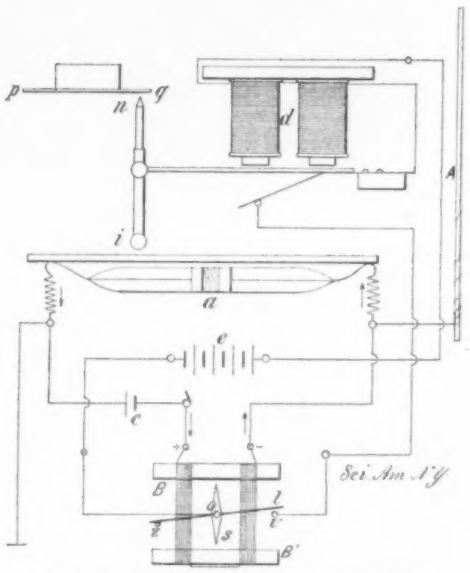
The prime defect of present painting resides entirely in the oil. Painting with oil, however, originated in remote times. According to some authors, it was introduced by Theophilus and Eraclius, and especially Jean Van Eyck, who lived at Brussels at the commencement of the fifteenth century. These painters, it is claimed, were ignorant of the distinction existing between pure linseed oil and siccative linseed oil. They, therefore, experienced unsurmountable difficulties in the drying. According to M. Henry, the method of painting with oil is much more ancient. A passage of the physician Aetius proves that the ancients, previous to Van Eyck, were acquainted with the siccative properties of nut oil.

Finally, I will say that the ancients produced a solution of wax in naphtha and in a light oil which they extracted from pitch, similar to our oil of turpentine, and that the method of applying the paint has changed comparatively little, except as to the employment of the *cauteria*.

The ancients employed a pencil and a brush and painted on canvas under the Roman emperors. The canvas was covered with a priming of oil, gum and glue. These paintings are almost always covered with a varnish.

During the last twenty years there has been a special attempt to reconstitute more or less perfectly the ancient processes for the making of paints or to create new formulas containing larger or smaller quantities of linseed oil. At last new products have been obtained, without the use of oil or varnishes. The study of these is interesting.

* From the French of Joseph Girard, Preparator to the Faculty of Science of Paris.—La Nature.



ELECTROGRAPH FOR ATMOSPHERIC DISCHARGES.

ELECTROGRAPH FOR ATMOSPHERIC DISCHARGES.

PROF. LANCETTA, director of the meteorological observatory of Girgenti (Sicily), has lately devised an instrument for revealing and registering the electric discharges of the atmosphere. His apparatus has the advantage of being simple in form and inexpensive. The coherer, *a*, is used to reveal the discharges; it is connected in series with the battery, *C*, and the galvanometer, *B B'*. The registering device is formed by the vibrator, *d*, whose armature carries at its free end a pencil, *n*, and a ball, *i*, which may strike the coherer. The pencil is arranged so as to trace a mark upon the cylinder, *p q*, which moves by clockwork. The vibrator is in series with a battery, *e*, and the pivot, *o*, of the galvanometer needle, *s*. When an atmospheric discharge acts upon the coherer and renders it conductive, the galvanometer needle is deflected and closes the circuit of the vibrator at *l v*. This causes the pencil to make a mark upon the registering cylinder, and the ball then falls and strikes the coherer, bringing it back to the normal state. The galvanometer needle thus comes back to the original position, its movement being regulated by the stop, *z*, so as to give it prompt action. The coherer is formed of two carbon rods which form a snug fit in a glass tube. The space between them is filled with grains of iron turnings, not too fine. The coherer is regulated at first by Leyden jar discharges and then the carbons are fixed in place by wax.

CONTEMPORARY ELECTRICAL SCIENCE.*

VIBRATIONS OF INCANDESCENT LAMP FILAMENTS.—The filament of an incandescent lamp is thrown into rapid vibrations in the cold state by the slightest disturbance. If it is held to the ear, a metallic note is heard, which appears to consist of several notes not harmonically related. When the lamp is burning the oscillations rapidly die away. This is not due to a loss of elasticity, since the pitch of the note heard remains the same; but there is probably a magnetic damping effect. The incandescent filament may be kept in a state of vibration by the simple device of bringing a magnet into its neighborhood, provided that either the lamp or the magnet is fed by an alternating current. The vibrations are not like those of Baun's cathode beam, strictly in unison with the current curve, but are practically sinusoidal. If two incandescent filaments are so arranged that their vibrations are normal to each other, the point of intersection, which appears black, describes Lissajous figures. If the two lamps are in parallel, the figure is a straight line. The vibration of the filament may, by a suitable arrangement of diaphragms, be used for producing intermittent illumination and for determining the periodicity of an alternating current by illuminating a rotating sector.—R. Kempff-Hartmann, Physikal. Zeitschr., August 24, 1901.

ZEEMAN EFFECT.—Reese has shown that the separation of the external components of the regular Zeeman triplet or quadruplet, as seen perpendicular to the lines of force, does not vary proportionally with the strength of the magnetic field in which the luminous source is placed. This fact was established for various zinc and cadmium lines up to a field of about 26,000 units. N. A. Kent has extended these researches to fields of 33,000 units, using a Rowland grating of 13 feet radius. The results show that the separation of the outer components of the zinc lines 4,680.38, 4,722.26, 4,810.71 is not proportional to the strength of the field. For iron lines chosen somewhat at random the same is true, and the lines which, in the ordinary iron spectrum, are "nebulous" in character show the least increase in Zeeman separation as the field is increased in strength. In other words, the curve plotted between the strength of field **H** and the resulting separation $\Delta\lambda$ shows the greatest droop. Preston's law that $\frac{\Delta\lambda}{\lambda \cdot \mathbf{H}}$ is a constant for homogeneous lines, holds not only for zinc, cadmium and magnesium, but also for mercury and cadmium.—N. A. Kent, Phil. Mag., September, 1901.

SIMULTANEOUS MULTIPLE AND ORDINARY TELEGRAPHY.—The simultaneous transmission of telegraphic and telephonic messages over the same wire is rendered possible by the difference in the effects produced by continuous and oscillating currents respectively. It follows that any system of telegraphy which employs oscillating currents offers the possibility of a simultaneous transmission of continuous and oscillatory messages. Such a system is that of E. Mercadier, who operates with electric tuning-forks. He has tested the possibility above indicated in a practical manner and on a large scale, and has succeeded in completely establishing it. The line worked with was that between Paris and Bordeaux. Among the various forms of auxiliary apparatus devised by Van Rysselberghe, Maiche, Cailho, Picard, etc., that of Cailho was chosen, and 12 simultaneous messages were transmitted by Mercadier's system, together with signals, with the Morse, Hughes, or Bandot transmitter. Since messages can be sent in both directions, this means that one wire can carry 25 messages at a time, together with extra messages between intermediate stations. This means a conveying capacity of some 1,300 telegrams of 20 words per hour, and a page of The Times could be transmitted from London to Dublin in half an hour.—E. Mercadier, Comptes Rendus, September 16, 1901.

ENERGY OF ROENTGEN RAYS.—Measurements of the energy of Roentgen rays have been made by Dorn, Schoeps and Rutherford, who found an average quantity of 0.0002 gramme-calorie per interruption. This result, fairly concordant as it is among the three independent observers, is doubted by F. Leininger, who also uses a bolometer method, but has not succeeded in obtaining any bolometer deflection at all, though a comparison between the sensitiveness of Rutherford's bolometer and his own shows that he had a right to expect a deflection of 19 scale divisions. Since one of the tubes used had an adjustable vacuum and could be studied both in very hard and a very soft condition, the negative result cannot be attributed to the hardness of the tubes. That the tube was highly efficient could be proved by its powerful fluorescent effects. The author cannot account for this discrepancy. It suggests the desirability of further independent investigations.—F. Leininger, Physikal. Zeitschr., August 31, 1901.

DISK INTERRUPTER FOR ALTERNATE CURRENTS.—E. Ruhmer reports some further improvements in the liquid interrupter with exchangeable perforated plates. The electrodes are introduced through the sides, thus obviating gliding sparks which might lead to explosions. By making one electrode of lead and the other of aluminium the author has succeeded in producing an apparatus which only interrupts the alternating current in one direction. This is of special utility in Roentgen ray work. The life of an aluminium electrode is about 500 hours.—E. Ruhmer, Physikal. Zeitschr., September 21, 1901.

LUMINOUS EFFECTS ON WIRES.—Bare wires appear surrounded by a luminous halo when they are connected with the secondary of an induction coil, and the circuit is either open or closed by means of a Crookes tube. Besides the halo bright stars appear on the wires at nearly equal intervals. To study this phenomenon in greater detail, J. Borgmann examined the behavior of such wires in tubes containing gas at various pressures. An essential difference was produced in the phenomena observed by inserting a spark-gap of less than 3 mm. in parallel with the induction coil. With-

* Compiled by E. E. Fournier d'Albe in The Electrician

out such a spark-gap there is no difference produced by a change of pole. As the exhaustion increases the stars become brighter, and are the centers of disks at right angles to the wire. They also increase in number, until finally they coalesce to a slightly stratified light column. On introducing the spark-gap, a decided difference is produced by connecting the tube with the positive or the negative pole of the induction coil respectively. The difference becomes the more marked the higher the vacuum. The stars only appear on connecting with the positive pole. On connecting with the negative pole a continuous halo surrounds the wire, which leaves the wire on further exhaustion and travels outward. When the pressure is only a few tenths of a millimeter, a series of dark green rings are seen on the wall of the tube, which revolve round the wire and travel along the tube. The approach of a conductor widens the interval between them, but a magnet produces no effect.—J. Borgmann, Physikal. Zeitschr., August 17, 1901.

THE ROZE "AVIATOR."

Some construct balloons and try to steer them, while others have faith only in apparatus heavier than the air. The Roze "Aviator" is a compromise between these two extreme solutions of the problem of aerial navigation. It participates in their advantages and also, of course, in their drawbacks.

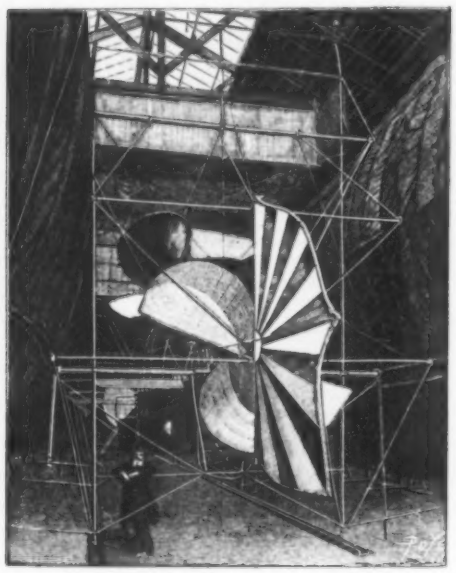


Fig. 1.—REAR VIEW OF THE CAR, SHOWING THE RUDDER, THE SCREWS, AND THE PARACHUTE.

In the present state of the science and industry of light motors, it would doubtless be difficult to construct a completely autonomous aeroplane, that is to say, one capable of rising by its own power. Let us deprive it of a part of its weight, said the inventor to himself, and, to this effect, let us suspend it from a balloon. Carrying out this idea, M. Roze has reduced the preponderance of the weight of the whole by 175 or 220 pounds, thinking that it will be easy for him to raise so feeble a load by means of screws. Is this a good idea? A definitive experiment will answer this and certain other questions.

Let us examine the "Aviator" which M. Roze is constructing in his vast shed at Colombes, and which is not a hasty improvization, but the fruit of long years of study. The sustaining apparatus consists of two huge pisciform balloons, 147.6 feet in length and 24.6 in diameter, each capable of holding 47,655 cubic feet of hydrogen. Between these balloons, which are fixed side by side by means of two superposed courses of three tubular cross-pieces of aluminium, with a system of braces that assure the invariability of the framework, there is sufficient space for the installation of the car, motors, and various propelling and steering apparatus. In the upper parts of the framework twelve silk-covered frames are arranged in parallel, like the slats of a gigantic Venetian blind. Further along, we shall see how this special apparatus is capable of performing the part of a parachute.

The balloons, which, like the Renard apparatus, have an elongation of six diameters, consist of an envelope of silk stretched over a skeleton formed of a series of parallel hoops formed of aluminium tubes connected by meridian arcs of the same nature. An aluminium cone at the point assures all the rigidity desirable. The fact is well known that in such huge receptacles there form great waves of gas which, by increasing the pitching, are capable of jeopardizing the stability. For the purpose of opposing such motions of ebb and flow, it long ago occurred to aeronauts to partition the interior of balloons. That of Count Zeppelin, 439.5 feet in length, contained 17 compartments. M. Roze, in adopting the same process, has provided each of his balloons with 12 cells separated by transverse diaphragms of silk. These partitions are provided with valves that permit of an equilibrium of pressure being established. It is equally indispensable that the same pressure shall always exist between the two balloons, if it is desired that they shall keep in the same plane of navigation. It has, therefore, been necessary to put them in communication through the intermedium of the six horizontal cross pieces of the framework, which, as before stated, are tubular.

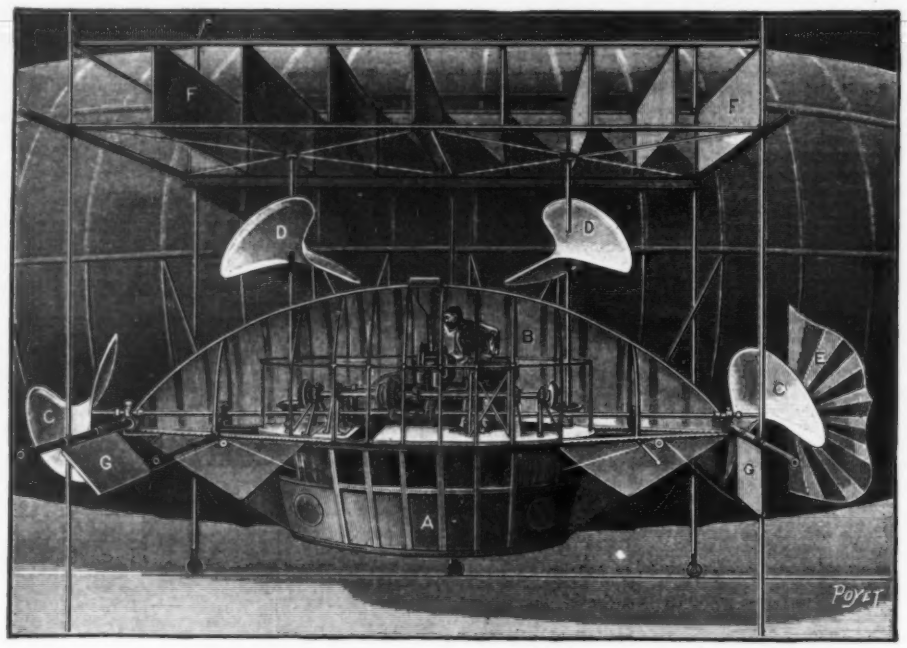


Fig. 3.—LONGITUDINAL SECTION OF THE CAR.

In the plans of the three lower crosspieces, curved pieces outline the edges of the deck of the car, the light frame of which is incurved into a keel 39.4 feet in length, while above the car there is an awning supported by an ogival frame. The deck thus divides the car into two stories situated between two of the crosspieces. In the center of the lower story there is a saloon separated by a partition of cloth from the cabin arranged in front for the captain, who from this point can maneuver the different rudders. The engineer, on the contrary, stands on the deck near the motors. The motive power is furnished by two two-cylinder gasoline motors cooled by water. Each of these motors is capable of developing 10 horse power. One of them is more especially designed for actuating, at 250 revolutions, the horizontal screws that produce the ascensional motion; but the entire motive power can be united upon the propelling screws, the velocity of which then reaches 500 revolutions. The propelling screws are two in number—one in front and the other in the rear. They are 11 feet in diameter and have a pitch of 16.4 feet. The two screws that produce the ascensional motion are identical and are placed above the car.

The steering rudder is arranged in the rear and in a direct line with the front screw. In addition, there are four horizontal rudders that perform the part of fins and are designed to regulate the inclination of the apparatus, and doubtless to overcome the rolling that might occur with two connected balloons.

But it is necessary to anticipate everything—even the case in which the ascensional screw might refuse to work. The "Aviator" in such an event would fall through its excess of weight (about 220 pounds), and the velocity of the fall would be accelerated in an exaggerated manner. In order to prevent any accident, M. Roze has devised a parachute that acts automatically in the descent. This, as above stated, consists of 12 bands of silk, which are 13 feet in length and 3 in width, and fixed upon light, but strong frames that are capable of oscillating around their upper horizontal edge. When the balloon rises, these frames hang horizontally and offer no resistance to the ascent, but, when it is moving forward, they cede to the thrust of the air and incline toward the rear; and, if the balloon descends, the resistance of the air (provided the motion is accelerated) becomes sufficient to raise the frames, which then place themselves in the same horizontal plane. There is thus obtained not only a parachute, but a true aeroplane, which, combined with the sustaining and steering screws, would permit of the most varied displacements by direct propulsion and by gliding through the air.

From the above brief description, it is easy to understand the modus operandi of the "Aviator," and to it may be added a few observations.

The use of aluminium for the skeleton, which is composed of no less than 11,800 feet of tubes, has per-

Fig. 2.—FRONT VIEW OF THE BALLOON.

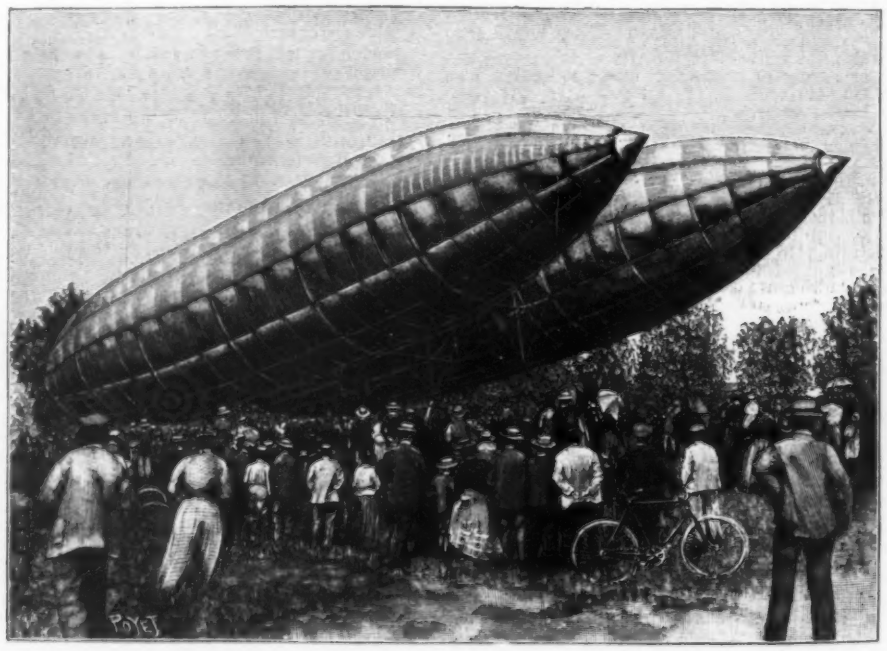


Fig. 4.—GENERAL VIEW OF THE "AVIATOR" DURING A TRIAL ASCENT.

mitted of reducing the total weight to a relative minimum, which, nevertheless, reaches 5,720 pounds. When to this is added the weight of the occupants of the car, that of the apparatus exceeds by from 175 to 220 pounds the thrust of the gas. But such residual gravity is desired by the inventor and forms part of his system. Unfortunately, the first trials have shown that it is yet too great.

The metal skeleton has, besides, many drawbacks, and the example of the German balloons of Schwartz and Zeppelin is not calculated to recommend it. Whatever may be done, it will render fortuitous landings in an open country difficult in case of a breakdown, despite the rubber-shod rollers with which the frame is provided. The resistance of the air is greatly increased by the wrinkles that the skeleton forms in the envelope, and especially by all the prominent parts of the framework.

Col. Renard has performed some very suggestive experiments upon the part played, in such resistance, by the suspension and cordage; but, far from reducing the surface of such parts, M. Roze has greatly increased them through the necessity of strongly crossbracing the balloons by means of tubes of wide diameter. The parachute itself will offer a great resistance to the horizontal motion by adding a portion of its surface to the very wide section of the central part of the double balloon. It would be necessary merely to compare the motive power per square foot of the central part of the Roze "Aviator" with balloons already experimented with in order to perceive that it is very feeble and will be able to afford but quite a low horizontal speed.

Another grave defect of the system resides in the great difficulty that will be experienced in making the numerous joints tight at the points where the tubes penetrate the envelope, and that, too, despite the precautions taken by the inventor. It seems, indeed, that such inconveniences have already exhibited themselves at the preliminary charging of the balloons with gas.

These are observations of a general nature that do not prevent a recognition of the ingenuity that the inventor has displayed in the solution of the numerous problems involved in quite a new conception; and it remains for us to wish that so many efforts shall be crowned with success. While M. Santos-Dumont has constructed the aerial voiturette, M. Roze has endeavored to give us a comfortable aerial omnibus; but, up to the present, the Metropolitan Railway need have no fear of a very serious competition. Quite recently, in fact, on the 5th and 6th of September, M. Roze endeavored to make a start in his balloon, but the latter was too heavy and was able to ascend only by virtue of its screws. It became necessary to raise it by hand

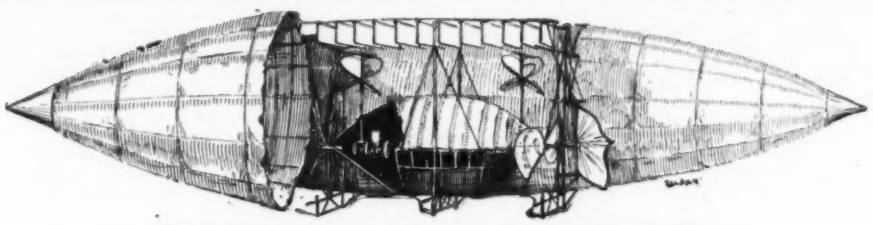


DIAGRAM SHOWING DETAILS OF CONSTRUCTION.

in order to launch it. M. Roze has recognized the necessity of lightening his balloon, and finds that he himself is too heavy to ascend in it. For the above particulars and a part of the engravings we are indebted to La Nature.

AN EFFECTIVE DEPILATORY.

DR. CHARLES GREENE CUMSTON observes in the Boston Medical and Surgical Journal that one of the most important points in surgical technique is the complete removal of hair from the field of operation. The razor is often badly tolerated, and shaving is difficult, especially of the scrotum, the vulva, and anus. In view of this Dr. Cumston has for some time employed with great advantage a paste of calcium hydrosulphate, as recommended by Raybaud, of Marseilles. The preparation of this paste is as follows: Two parts of freshly slaked lime, from which all grit has been removed, are mixed with three parts of water. The resulting milk of lime is traversed by a current of sulphureted hydrogen. The milk of lime becomes pasty, and from milky white the mass becomes a bluish green. The odor of sulphureted hydrogen is not very pronounced. This product is not caustic in the slightest degree, and may be manipulated without any fear. It will not soil the hands unless they are moistened with a solution of some mercurial salt whose metal is precipitated by sulphureted hydrogen. The paste must be put up in brown glass bottles and well corked, because calcium hydrosulphate is decomposed by both light and air, more especially the latter. The carbonic acid in the air liberates the sulphureted hydrogen and transforms the paste into an inert carbonic compound.

The way of employing this paste is very simple. With a spatula or spoonhandle a thin layer is spread on the parts from which the hair is to be removed. If the hair is very long it may be clipped off with the scissors first, but this precaution is not necessary if one is careful to see that the paste is applied down to the skin. The paste is left on for five minutes and then with tepid water and a towel it is removed by gentle friction. The skin will then be found to be free from any trace of hair and better shaven than by the cleverest barber. Dr. Cumston says that the paste is absolutely devoid of any irritating properties to the skin, is painless, and leaves no trace behind. The hair grows again perfectly, just as when it has been removed with the razor. In scalp wounds, in genito-urinary, rectal, and gynecic surgery, it is much better than the razor, as a perfectly smooth skin results.

Detonating Device in France.—M. Aubert, a local inventor, has produced a successful apparatus for exploding dynamite with safety in coal mines where gas is present in dangerous volume, without the use of electricity, the installation of which is always costly and subject to disarrangement.

The instrument seems to cover the exposed end of the safety fuse, to fire it, and to receive all flame and sparks thrown off without allowing any communication with the atmosphere.

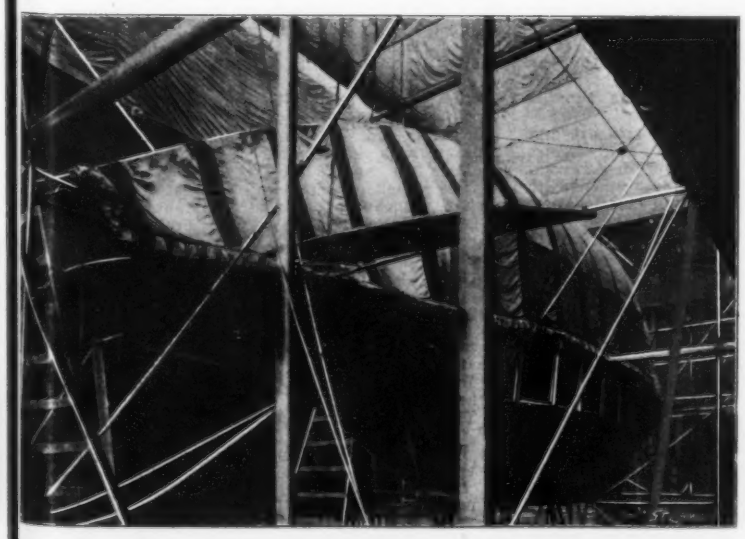
A copper tube receives the end of the tube to a depth of several inches. At the other end of the tube is fixed a percussion cap, similar to those used in toy pistols and lying against the side of the tube, which is pierced in its turn by a small hole. The distance between the extending end of the fuse and the percussion cap is only 2 millimeters (0.07 inch). The end of the tube with the percussion cap is introduced into another cylinder, also of copper, which contains the firing mechanism. To operate the apparatus, the tube containing the fuse is held in the left hand while with the palm of the right a smart blow is struck on the button of the percutient, when the cap explodes.

The gas produced by the fuse fills the cylinder, but cannot escape outside, unless extinguished, as the holes in the cylinder are covered with metallic gauze. In practice, the tubes are prepared outside, in the daytime, by the lamp cleaner, so that no stray percussion caps may be brought into the mine.

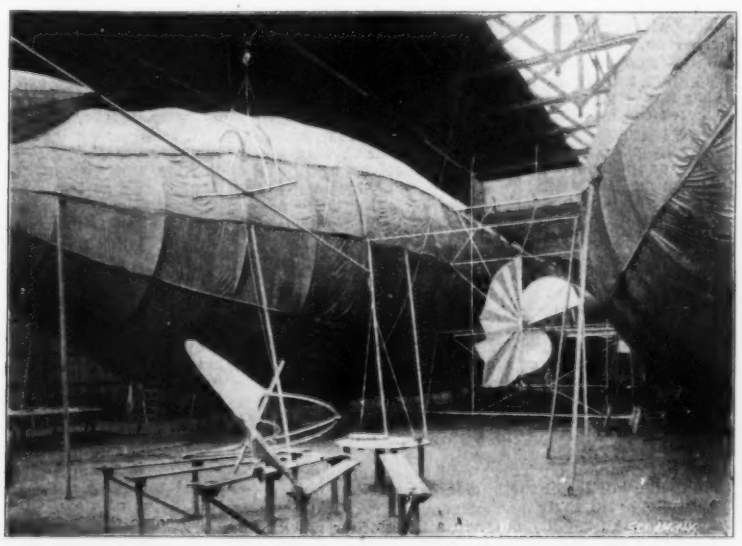
Each foreman whose business it is to supervise the blasting takes into the mine a case containing the number of tubes required for the day, and brings them back at night to be recharged.

This simple apparatus has been in use for the last few months in one of the St. Etienne mines, as well as in the north of France. It is reported to be giving much satisfaction, being both economical and sure in its workings.—Hilary S. Brunot, Consul at St. Etienne.

FRAMEWORK OF THE ROZE TWIN AIRSHIPS DURING CONSTRUCTION.



VIEW OF THE CAR SHOWING ONE OF THE HORIZONTAL RUDDERS.



REAR VIEW SHOWING REAR HELICE AND VERTICAL RUDDER.

LUMINOSITY OBTAINED FROM CERTAIN ORGANIC COMPOUNDS.*

CALLAND, a pharmacist at Annecy, claims to have been the first to ascertain the luminosity of heated sulphate of quinine. This was in 1821. The same year Pelletier repeated and completed the experiments of Calland, and observed that the sulphate of cinchonine had the same property. Inspired by the experiments of Calland and Pelletier, Radzizewski, as he has himself declared, excited the luminosity of certain organic substances by heating them with alcoholic potassium. The luminosity could also be aroused, cold, by lophine.

I have myself ascertained that a large number of organic compounds belonging to families chemically different, not examined by Radzizewski, become luminous with heat in presence of alcoholic potassium.

I have also been able to obtain luminosity, cold, with organic products not known as photogens.

Some of these are the following: Oils of chamomile, rosemary, cumin, illicium anisatum. The oil of roses gleams also, cold, with alcoholic potassium, a fact which distinguishes it from oil of geranium and that of pelargonium. Perhaps certain adulterations of frequent occurrence may be detected by photometric tests. We must always be on guard against some causes of error; thus, oil of turpentine, which is not luminous, cold, with alcoholic potassium, gives a feeble and trans-

* From the French of M. Raphael Dubois. Paper presented to the Academie des Sciences.

itory luminosity when it is old and partially oxidized. To obtain the highest luminosity, there must be varied concentrations of the alcoholic solution of caustic alkali. The quality of the substance to be tested must also be well known.

Through the kindness of Prof. Florence of the University of Lyons, I have been able to operate on a considerable quantity of well defined principles.

Of all the bodies tested, none has given me more satisfactory results than esculine, a body not studied by Radziewski. This glucoside furnishes in alcoholic potassium a luminosity as beautiful as that of the mucus of the *Pholas dactylus*, but while the luminosity of the latter is at once extinguished by strong alcohol and excited by water, the brilliancy of the alcoholic potassium liquor of esculine is instantaneously destroyed by the addition of water.

Fluorescent substances are very rare among animals and vegetables, but it is interesting to note that esculine has at the same time the properties of fluorescence and of luminosity by oxidation.

I have demonstrated the existence in the luminous organs of *Pyrophorus noctilucus* of a fluorescent substance which I call pyrophorine, while fluorescence is destroyed by acetic acid and excited by ammonia. An alcoholic potassium solution of esculine gave during an entire night a beautiful luminosity which increased greatly when agitated in contact with the air. Its luminous intensity varies with the purity of the product employed. Here, also, the photometric test may allow us to estimate the quality of esculine.

ANTHROPOLOGY.*

By Prof. D. J. CUNNINGHAM, M.D.

TWENTY-FIVE years have passed since the British Association met in Glasgow. This is a long time to look back upon, and yet the period appears short when measured by the great advance which has taken place in almost all branches of knowledge. Anthropology has shared in the general progress. The discoveries made within its confines may not have been so startling, nor yet have had such a direct influence upon the material welfare of the people, as in the case of other fields of scientific study, but its development has been steady and continuous, and it has grown much in public estimation.

At the Glasgow meeting of the Association in 1876 Anthropology held a subsidiary position. It only ranked as a department, although it gained a special prominence through having Alfred Russel Wallace as its chairman. It was not until several years later that it became one of the recognized Sections of the Association, and attained the high dignity of having a letter of the alphabet allotted to it. But quite independently of its official status it has always been a branch of study which has been accorded a large amount of popular favor. The anthropological meetings have, as a rule, been well attended, and the discussions, although perhaps on certain occasions somewhat discursive, have never lacked vigor or animation. Prof. Huxley, who presided over the Anthropological Department at the Dublin meeting in 1878, ascribed the popularity of the subject to the many openings which it affords for wide differences of opinion between the exponents of its numerous branches and to the innate bellicose tendency of man. As the representative of a country in which, according to the same high authority, this tendency is less strongly marked than elsewhere, and of a race which has so frequently and pointedly exhibited its abhorrence of vigorous language, I trust that my presence here as president may not react unfavorably on the interest shown in the work of the Section.

The present occasion might appear to be peculiarly appropriate for my taking stock of our anthropological possessions and summing up the numerous additions to our knowledge of "man and his doings" which have been made during the century which has just passed. Such a task, however, is surrounded with so much difficulty that I shrink from undertaking it. The scope of the subject is enormous, and the studies involved so diverse and so varied that I feel that it is beyond my power to give any comprehensive survey of its development in all its parts. I prefer therefore to confine my remarks to that province of Anthropology within which my own work has been chiefly carried on, and from this to select a subject which has for some years held a prominent place in my thoughts. I refer to the human brain and the part which it has played in the evolution of man.

One of the most striking peculiarities of man when regarded from the structural point of view is the relatively great size of his brain. Although with one or two exceptions the several parts of the brain are all more or less involved in this special development, it is the cerebral hemispheres which exhibit the preponderance in the highest degree. This characteristic of the human brain is rendered all the more significant when we consider that the cerebral hemispheres cannot be looked upon as being primitive parts of the brain. In its earliest condition the brain is composed of three simple primary vesicles, and the cerebral hemispheres appear in a secondary manner in the shape of a pair of lateral offshoots or buds which grow out from the foremost of these primitive brain-vesicles.

The offshoots which form the cerebral hemispheres are found in all vertebrates. Insignificant in size and insignificant in functional value in the more lowly forms, a steady increase in their proportions is manifest as we ascend the scale, until the imposing dimensions, the complex structure, and the marvelous functional potentialities of the human cerebral hemispheres are attained. In their development the cerebral hemispheres of man rapidly outstrip all the other parts of the brain until they ultimately usurp to themselves by far the greater part of the cranial cavity. To the predominant growth of the cerebral hemispheres is due the lofty cranial vault of the human skull; to the different degrees of development and to the different forms which they assume are largely due the variations in cranial outline in different individuals and different races—variations in the determination of which the craniologist has labored so assiduously and patiently.

I think that it must be manifest to everyone that the work of the craniologist, if it is to attain its full degree of usefulness, must be founded upon a proper recognition of the relation which exists between the cranium and the brain, or, in other words, between the envelope and its contents.

The cranium expands according to the demands made upon it by the growing brain. The initiative lies with the brain, and in normal conditions it is questionable if the envelope exercises more than a very subsidiary and limited influence upon the form assumed by the contents. The directions of growth are clearly defined by the sutural lines by which the cranial bones are knit together; but these are so arranged that they admit of the expansion of the cranial box in length, in breadth, and in height, and the freedom of growth in each of these different directions has in all probability been originally determined by the requirements of the several parts of the brain.

The base or floor of the cranium, supporting as it does the brain-stem, or the parts which possess the greatest phylogenetic antiquity, and which have not undergone so large a degree of modification in human evolution, presents a greater uniformity of type and a greater constancy of form in different individuals and different races than the cranial vault which covers the more highly specialized and more variable cerebral hemispheres.

To what extent and in what directions modifications in the form of the cranium may be the outcome of restrictions placed on the growth of the brain it is difficult to say. But, broadly speaking, I think we may conclude that the influence which the cranium, under normal circumstances, independently exerts in determining the various head-forms is trifling.

When we speak therefore of brachycephalic, or short heads, and dolichocephalic, or long heads, we are merely using terms to indicate conditions which result from individual or racial peculiarities of cerebral growth.

The brachycephalic brain is not molded into form by the brachycephalic skull; the shape of both is the result of the same hereditary influence, and in their growth they exhibit the most perfect harmony with each other.

Craniology has been called the "spoiled child of anthropology." It is supposed that it has absorbed more attention than it deserves, and has been cultivated with more than its share of care, while other fields of anthropology capable of yielding rich harvests have been allowed to remain fallow. This criticism conveys a very partial truth. The cranium, as we have seen, is the outward expression of the contained brain, and the brain is the most characteristic organ of man; cranial peculiarities therefore must always and should always claim a leading place in the mind of the anthropologist; and this is all the more imperative seeing that brains of different races are seldom available for investigation, while skulls in the different museums may be counted by thousands.

Meantime, however, the craniologist lies buried beneath a mighty mountain of figures, many of which have little morphological value and possess no true importance in distinguishing the finer differences of racial forms. Let us take as an example the figures upon which the cephalic or length-breadth index of the skull is based. The measurement of the long diameter of the cranium does not give the true length of the cranial cavity. It includes, in addition, the diameter of an air-chamber of very variable dimensions which is placed in front. The measurement combines in itself therefore two factors of very different import, and the result is thereby vitiated to a greater or less extent in different skulls. A recent memoir by Schwalbe* affords instructive reading on this matter. One case in point may be given. Measured in the usual way, the Neanderthal skull is placed in the dolichocephalic class; whereas Schwalbe has shown that if the brain-case alone be considered it is found to be on the verge of brachycephaly. Huxley, many years ago, remarked that "until it shall become an opprobrium to an ethnological collection to possess a single skull which is not bisected longitudinally" in order that the true proportions of its different parts may be properly determined, we shall have no "safe basis for that ethnological craniology which aspires to give the anatomical characters of the crania of the different races of mankind." It appears to me that the truth of this observation can hardly be disputed, and yet this method of investigation has been adopted by very few craniologists.

It has become too much the habit to measure and compare crania as if they were separate and distinct entities, and without a due consideration of the evolutionary changes through which both the brain and its bony envelope have passed. Up to the present little or no effort has been made to contrast those parts of the cranial wall or cavity which have been specially modified by the cerebral growth-changes which are peculiar to man. It may be assumed that these changes have not taken place to an equal extent, or indeed followed identically the same lines in all races.

Unfortunately our present knowledge of cerebral growth and the value to be attached to its various manifestations is not so complete as to enable us to follow out to the full extent investigations planned on these lines. But the areas of cerebral cortex to which man owes his intellectual superiority are now roughly mapped out, and the time has come when the effect produced upon the cranial form by the marked extension of these areas in the human brain should be noted and the skulls of different races contrasted from this point of view.

To some this may seem a return to the old doctrine of phrenology, and to a certain extent it is; but it would be a phrenology based upon an entirely new foundation and elaborated out of new material.

It is to certain of the growth-changes in the cerebrum which I believe to be specially characteristic of man, and which unquestionably have had some influence in determining head-forms, that I wish particularly to refer in this address.

The surface of the human cerebrum is thrown into a series of tortuous folds or convolutions separated by slits or fissures, and both combine to give it an appearance of great complexity. These convolutions were long considered to present no definite arrangement, but to be thrown together in the same meaningless disorder as is exhibited in a dish of macaroni. During the latter half, or rather more, of the century which has just ended it has, however, been shown by the many eminent men who have given their attention to this subject that the pattern which is assumed by the convolutions, while showing many subsidiary differences, not only in different races and different individuals, but also in the two hemispheres of the same person, is yet arranged on a consistent and uniform plan in every human brain, and that any decided deviation from this plan results in an imperfect carrying out of the cerebral function. In unraveling the intricacies of the human convolutionary pattern it was very early found that the simple cerebral surface of the ape's brain in many cases afforded the key to the solution of the problem. More recently the close study of the manner in which the convolutions assume shape during their growth and development has yielded evidence of a still more valuable kind. We now know that the primate cerebrum is not only distinguished from that of all lower mammals by the possession of a distinct occipital lobe, but also by having imprinted on its surface a convolutionary design, which in all but a few fundamental details is different from that of any other order of mammals.

There are few matters of more interest to those anthropologists who make a study of the human skull than the relationship which exists between the cranium and the brain during the period of active growth of both. Up to the time immediately prior to the pushing out of the occipital lobe, or, in other words, the period in cerebral development which is marked by the transition from the quadrupedal type to the primate type of cerebrum, the cranial wall fits like a tight glove on the surface of the inclosed cerebrum. At this stage there would appear to be a growth antagonism between the brain and the cranial envelope which surrounds it. The cranium, it would seem, refuses to expand with a speed sufficient to meet the demands made upon it for the accommodation of the growing brain. In making this statement it is right to add that Hochstetter, in a carefully reasoned memoir, has recently cast doubt upon the reality of the appearances which have led to this conclusion, and at the recent meeting of the Anatomische Gesellschaft, in Bonn, Prof. Gustaf Retzius,* one of the numerous observers responsible for the description of the early cerebrum upon which the conclusion is based, showed some inclination to waver in his allegiance to the old doctrine. This is not the time or the place to enter upon a discussion of so technical a kind, but I may be allowed to say that while I fully recognize the necessity for further and more extensive investigation into this matter I do not think that Hochstetter has satisfactorily accounted for all the circumstances of the case.

When the occipital lobe assumes shape the relationship of the cranial wall to the inclosed cerebrum undergoes a complete change. The cranium expands so rapidly that very soon a wide interval is left between the surface of the cerebrum and the deep aspect of the cranial envelope within which it lies. This space is occupied by a soft, sodden, spongy, meshwork, termed the subarachnoid tissue, and it is into the yielding and pliable bed thus prepared that the convolutions grow. At first the surface of the cerebral hemisphere is smooth, but soon particular areas of the cortex begin to bulge out and foreshadow the future convolutions. These suffer no growth restriction, and they assume the form of round or elongated elevations or eminences which rise above the general surface level of the cerebral hemisphere and break up its uniform contour lines in the same manner that mountain chains protrude from the surface of the globe.

As growth goes on, and as the brain gradually assumes a bulk more nearly in accord with the cavity of the cranium, the space for surface protrusions of this kind becomes more limited. The gyral elevations are now pressed together; they become flattened along their summits, and in course of time they acquire the ordinary convolutionary shapes. While this is going on the valleys or intervals between the primitive surface elevations become narrowed, and ultimately assume the linear slit-like form characteristic of the fissures. These changes occur shortly before birth, but are not fully completed until after the first few months of infancy. The final result of this process is that the convolutions come into intimate relation with the deep aspect of the cranial wall and stamp their imprint upon it.

It is obvious that certain of the later changes which I have endeavored to portray might be ascribed to a growth antagonism between the brain and the inclosing cranium at this period. In reality, however, it is merely a process by which the one is brought into closer adaptation to the other—a using up, as it were, of superfluous space and a closer packing together of the convolutions—after the period of active cortical growth is past. Nevertheless the convolutionary pattern is profoundly affected by it, and it seems likely that in this process we find the explanation of the different directions taken by the cerebral furrows in brachycephalic and dolichocephalic heads.

The cortical elevations which rise on the surface of the early cerebrum are due to exuberant growth in localized areas. There cannot be a doubt that the process is intimately connected with the development of function in the districts concerned. We know that functions of different kinds are localized in different parts of the cortex, and when we see an area on the surface of the early cerebrum rise up in the form of an eminence we may reasonably conclude that the growth in the area concerned is the structural foundation of what will become later on a center of functional activity of an acute kind.

A consideration of this matter gives the clew to the simple convolutions of the ape and the complex convolutions of man, and, further, it explains how the interrupted form of fissural development is one of the

* Opening address by the President of the Section, before the Meeting of the British Association at Glasgow.

* "Studien über Pithecanthropus erectus" (Dubois). Zeitschrift f. Morph. und Anthrop., Band 1. Heft. 1, 1899.

* Anatomische Gesellschaft, Bonn, May 21, 1901. Gustaf Retzius, "Transitorische Furchen des Grosshirns."

essential characteristics of the human brain as compared with the simian brain. Areas which rise up in the form of one long elevation on the surface of the ape's brain appear in the form of several eminences on the surface of the human brain, and fissures which appear in the form of long continuous slits in the simian cerebrum appear in the human cerebrum in several detached bits, which may or may not in the course of time run into each other and become confluent. All this is due to the greater definition, refinement, and perfection of the functions carried on in the cerebral cortex of man. It is an index of a more complete "physiological division of labor" in the human brain.

It is not necessary, for the purpose I have in view, to enter into any detail regarding the many points of difference which become evident when the cerebral surface of the ape is compared with that of man. It is more my purpose to indicate certain of the districts of cerebral cortex which have undergone a marked increase in the human brain—an increase which may be reasonably supposed to be associated with the high mental attributes of man. To us, at the present time, it is difficult to conceive how it was ever possible to doubt that the occipital lobe is a distinctive character of the simian brain as well as of the human brain, and yet at successive meetings of this Association (1860, 1861, and 1862) a discussion, which was probably one of the most heated in the whole course of its history, took place on this very point. One of our greatest authorities on animal structure maintained that the occipital lobe and the hippocampus minor—an elevation in its interior—were both peculiar to man and to him alone. Everyone has read in the "Water Babies" Charles Kingsley's delightful account of this discussion. Speaking of the Professor he says: "He held very strange theories about a good many things. He had even got up at the British Association and declared that apes had hippopotamus majors in their brains just as men have. What a shocking thing to say; for if it were so, what would become of the faith, hope and charity of immortal millions? You may think that there are other more important differences between you and an ape, such as being able to speak, and make machines, and know right from wrong, and say your prayers, and other little matters of that kind; but that is a child's fancy." In the light of our present knowledge we can fully understand Prof. Huxley closing the discussion by stating that the question had "become one of personal veracity." Indeed, the occipital lobe, so far from being absent, is developed in the ape to a relatively greater extent than in man, and this constitutes one of the leading positive distinctive characters of the simian cerebrum. Measured along the mesial border, the percentage length of the occipital lobe to the total length of the cerebrum in the baboon, orang, and man is as follows:

Baboon	29.7
Orang	23.2
Man	21.2

But these figures do not convey the full exent of the predominance of the occipital lobe in the ape. The anterior border of the lobe grows forward beyond its proper limits, and pushes its way over the parietal lobe which lies in front, so as to cover over a portion of it by an overlapping lip termed the occipital operculum. There is not a trace of such an arrangement in the human brain, and even in the anthropoid ape the operculum has become greatly reduced. Indeed, in man there is exactly the reverse condition. The great size of the parietal lobe is a leading human character, and it has partly gained its predominance by pushing backward so as to encroach, to some extent, upon the territory which formerly belonged to the occipital lobe.* A great authority† on the cerebral surface refers to this as a struggle between the two lobes for surface extension of their respective domains. "In the lower apes," he says, "the occipital lobe proves the victor: it bulges over the parietal lobe as far as the first annectant gyrus. Already, in the orang, the occipital operculum has suffered a great reduction; and in man the victory is on the side of the parietal lobe which presses on the occipital lobe and begins, on its part, to overlap it." Now that so much information is available in regard to the localization of function in the cerebral cortex, and Flechsig has stimulated our curiosity in regard to his great "association areas" in which the higher intellectual powers of man are believed to reside, it is interesting to speculate upon the causes which have led to the pushing back of the scientific frontier between the occipital and parietal cerebral districts.

The parietal lobe is divided into an upper and a lower part by a fissure, which takes an oblique course across it. Rudinger,‡ who studied the position and inclination of this fissure, came to the conclusion that it presents easily determined differences in accordance with sex, race and the intellectual capacity of the individual. He had the opportunity of studying the brains of quite a number of distinguished men, among whom were Bischoff of Bonn, Döllinger of Munich, Tiedemann of Heidelberg, and Liebig of Munich, and he asserts that the higher the mental endowment of an individual the greater is the relative extent of the upper part of the parietal lobe.

There is absolutely no foundation for this sweeping assertion. When the evolutionary development of the parietal part of the cerebral cortex is studied exactly the reverse condition becomes manifest. It is the lower part of the parietal lobe which in man, both in its early development and in its after growth, exhibits the greatest relative increase. Additional interest is attached to this observation by the fact that recently several independent observers have fixed upon this region as one in which they believe that a marked exuberance of cortical growth may be noted in people of undoubted genius. Thus Retzius has stated that such was the case in the brains of the astronomer Hugo Gyldén,* and the mathematician Sophie Kovalevsky;† Hansemann‡ has described a similar condition in the brain of Helmholtz; and Guszman§ in the brain of Rudolph Lenz, the musician. Some force is likewise added to this view by Flechsig, who, in a recent paper,‖ has called attention to the fact that within this district there are located two of his so-called "Terminalgebiete," or cortical areas, which attain their functional powers at a later period than those which lie around them, and which may therefore be supposed to have specially high work to perform.

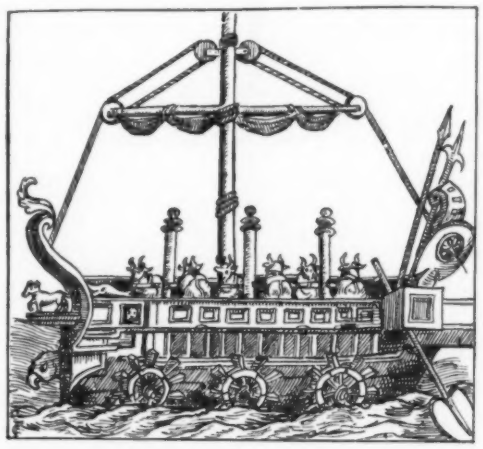
Without in any way desiring to throw doubt upon the observations of these authorities, I think that at the present moment it would be rash to accept, without further evidence, conclusions which have been drawn from the examination of the few brains of eminent men that have been described. There cannot be a doubt that the region in question is one which has extended greatly in the human brain, but the association of high intellect with a special development of the region is a matter on which I must confess I am at present somewhat skeptical.

But it is not only in a backward direction that the parietal lobe in man has extended its territory. It has likewise increased in a downward direction. There are few points more striking than this in the evolution of the cerebral cortex of man. In order that I may be able to make clear the manner in which this increase has been brought about, it will be necessary for me to enter into some detail in connection with the development of a region of cerebral surface termed the insular district. The back part of the frontal lobe is also involved in this downward extension of surface area, and, such being the case, it may be as well to state that the boundary which has been fixed upon as giving the line of separation between the parietal and frontal districts is purely artificial and arbitrary. It is a demarkation which has no morphological significance, while from a physiological point of view it is distinctly misleading.

(To be continued.)

A VERY ANCIENT METHOD OF PADDLE PROPULSION.

THE old saying that there is nothing new under the sun is forcibly illustrated in the annexed reproduction of an old wood-cut taken from a work on naval



A PADDLE WARSHIP OF SIX OX-POWER.

FROM A WOOD-CUT PUBLISHED IN 1560.

and military matters published in 1560. It will be seen from this that the possibilities of moving a ship by some mechanical contrivance withinboard other than oars had been considered long before the advent of steam enabled the artist's dream of movement by ox-power to be realized by engines of many hundreds or even thousands of horse power. But, according to the writer of the work from which this quaint example of naval architecture is taken, it is the representation of a ship which was in use many hundreds of years before even his epoch. He says he takes it from an old Latin book on warlike affairs (he himself uses the same classical language, by the way) the writer of which asserted that he had seen such a vessel with his own eyes. Although this remarkable warship presents an extremely fantastic, not to say grotesque, appearance, the method of propulsion is indicated with a fair amount of clearness. It is evident that each pair of oxen moving round in a circle cause one of the three vertical spindles or capstans to revolve by pushing against a species of capstan bar. These spindles from their position may be certainly assumed to be connected by suitable gearing to the paddle-wheels beneath; and when the chief engineer (who seems to be looking out of the bow port) put his bovine engines to "full speed ahead" and turns on the forced draught with goad or lash, it is possible that a knot an hour may have been logged under sufficiently favorable circumstances.

It will be observed that sail-power was provided in case of a breakdown of the engines. The standing rigging is not indicated, but it will be seen that the tackles for hoisting the sail were made strong enough to stand the heaviest strains. Aft we see the boarding pikes of the period laid ready for instant use, a powerful steering oar, and an overhanging bridge or sponson from which the skipper could con the ship. The bow presents the highly decorated appearance that continued till a comparatively recent date. There is scrollwork and a figure-head representing an animal of an uncertain genus, while below is what is probably intended for an eagle's head, though bearing a strong resemblance to the domestic parrot. Here we have the "beak" and the "eyes" of the ship in one, and altogether it may be safely asserted that a more weird and wonderful war vessel has rarely if ever been pictured.

JAPANESE PLANTS IN AMERICAN GARDENS.

JAPANESE plants that may be used to ornament American gardens furnish the theme of a delightful, if somewhat technical, article by Frances Duncan in the September Atlantic Monthly. The writer protests against the custom of regarding Japanese plants and trees as if nature grew only in miniature in the Land of the Rising Sun. She says that "when one hears of Japanese trees it is not the great hemlock forests of Lake Yumoto, nor the giant cryptomerias of Nikko that come before the mind, . . . but a horticultural curio—a miniature tree, marvelously gnarled and dwarfed, with a pedigree going back to the time of Cromwell; a result of Japanese brains and Japanese ingenuity, but certainly no adequate representative of nature's work on Japanese soil."

Is not this criticism equally true as to the general conception in this country of things Japanese—nature in miniature; a fine, charming, alluring, splendid nature, but diminutive?

Japan has its big trees also, that rank with the great sequoia of California; it has its marvelous plant and flower life, that excels that of America in beauty and in hardiness as well. Of these qualities of the Japanese flora, the writer has many pleasant things to say:

"One of the most distinctive characteristics of the Japanese plant, compared with its American brothers, is a sort of holiday appearance, a touch of an older civilization and culture than ours; as if a country lass, who had been educated away from home, given a year or two of Paris by way of 'finishing,' should come back and stand again among her sisters who had never left the home farm; they might have the same rosy cheeks, the same features, but would lack the indescribable touch of culture, the grace of manner which would make her perfectly at ease where her sisters would feel awkward and uncomfortable.

"Beautiful as our apple tree is in blossom time, it should never leave the orchard. A New England spinster is not more settled in her habits. Stiff and unbending, the smallest tree never looks really young; the infectious gayety of a March wind, which makes an old elm forget his years and toss his boughs like a birch sapling, will only set its smallest twigs a-flutter in a vain attempt to enter into the spirit of the thing; the branches remain in unmoved primness. But the Japanese apple tree from its infancy is a thing of gracefulness and charm; and the blossoms—there are none like them in all the beautiful race of flowering trees. The profusion of apple blossoms combined with the delicacy of a wild rose! The leaves are small, shining, and more abundant than those of the common apple, and the blossoms hang in clusters from the lower side of the branches, each like a tiny rosebud.

"Our cherry tree escapes the spinster-like aspect of the apple, but it is under the same ban. It may be picturesque in its old age, covered with snowy blossoms; it may even be one of those motherly-looking trees which Mme. de Sevigne wished to embrace; still it is as hopelessly out of place on a smooth-shaven lawn as a dear old 'mammy' at an afternoon tea. On the other hand, the Japanese cherry sways its drooping branches with the air of one 'to the manner born,' and is charming to look on at all times, especially in May, when, to the tip of the smallest branchlet, it is hidden under a mist of delicate rose-colored blossoms, the whole tree having the airy lightness of an acacia."

As to the adaptability of the Japanese plants and flowers for American gardens, the writer says:

"The Italian garden is suited to but few of our villas and country houses. It is true that we lack the architectural accompaniments, the balustrades and terraces, but still more do we lack the patience to wait the necessary years of growth. We Americans do not plant for posterity; our children may live abroad, or they may pull down our barns and build greater, demolishing the gardens at the same time. But the Japanese plants are especially adapted to American lawns and gardens; they give a touch of ornateness to the simplest cottage, and harmonize perfectly with the more pretentious mansion."

THE PHOSPHATES IN STRAWBERRY CULTURE.

THE culture of strawberries in the environs of Paris and in the South of France (Vaucluse and Var) has assumed large proportions. In the arrondissement of Carpentras the results have been extraordinary. In that favored country the trade in prime fruit reaches every year a respectable number of millions of francs. The last shipments to Paris, London, and the large cities of the North of France and of Europe amounted to about six millions of kilogrammes. The cultivation is attended with the greatest care. The operators apply the best methods, and are not afraid, in order to obtain the maximum production, to make extensive use of chemical and other fertilizers. However, the phosphates, properly so called, have hitherto been put only under imperfect contribution. This certainly will not be the case after the remarkable experiments of M. Condon, the expert chemist of the Agricultural Institute.

M. Condon has demonstrated conclusively that an application of chemical fertilizers (sodium nitrate, superphosphate, potassium chloride) increases the yield and prolongs the season. His method consists in applying by mulching in the month of March the following fertilizers per "are" of land: 7 kilos of sodium nitrate, 2 kilos of superphosphate, and 4 kilos of potassium chloride. This combination costs scarcely three francs a year, and yet occasions an increased production of 65 to 70 kilos. The experiments, many times repeated, have led to this conclusion.

The square enriched with the chemical fertilizers

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* It is necessary to emphasize this point, because in Wiedersheim's "Structure of Man" we are told that in man there is a preponderance of the occipital lobe, and that the parietal lobe is equally developed in man and anthropoids.

† Eberstaller, Wiener Medizinische Blätter, 1884, No. 19, p. 581.

‡ "Beitrage zur Anatomie und Embryologie," als Festgabe, Jacob Henle, 1882.

* Retzius, Biologische Untersuchungen, neue Folge, viii, 1898, "Das Gehirn des Astronomen Hugo Gyldéns."

† Retzius, Biologische Untersuchungen, neue Folge, ix, 1900, "Das Gehirn der Mathematikerin Sonja Kovalevsky."

‡ Hansemann, Zeitschrift für Psychologie und Physiologie der Sinnesorgane, Band xx. Heft 1, 1899, "Ueber das Gehirn von Hermann v. Helmholtz."

§ Josef Guszman, Anatomischer Anzeiger, Band xix. Nos. 9 and 10, April, 1901, "Beiträge zur Morphologie der Gehirnoberfläche."

‖ Flechsig, "Neue Untersuchungen über die Markbildung in den menschlichen Grosshirnlappen," Neurologisches Centralblatt, No. 21, 1898.

has produced 203 kilos of strawberries per are, while the square reserved for comparison has produced only 137 kilos; a difference of 66 kilos. As is seen, it is well worth the trouble of using the superphosphate, the nitrate and other superior fertilizing materials, since an increase of almost 50 per cent is secured; that is, an additional expense of three francs is attended with a profit averaging 30 francs per are. We say on the average, for it is necessary to take into account the fluctuations of the market, and also the methods of cultivation made use of, the open, the semi-forced, and the forced cultivation; all these are in practice in the districts where the strawberry has become an important object of industry.—Translated from Le Phosphate.

SORGHUM SIRUP MANUFACTURE.*

By A. A. DENTON, Medicine Lodge, Kan.

INTRODUCTION.

FARMERS' Bulletin No. 90 contained results of experimental work in sorghum-sirup manufacture by the writer to the time it was written. The present bulletin contains the results of subsequent experimental work in the same line, though it is not now considered complete. There is much promise of general improvement in the quality of sorghum sirup as the result of further experimental work, and this bulletin, not intended as a complete treatise on sorghum-sirup manufacture, deals almost exclusively with the improving of the sirup by removing impurities from the juice.

The methods described have special reference to small sirup factories which have only the simplest apparatus. Promising processes suited only to well-equipped steam sirup factories are not discussed. By far the greater part of the 25,000,000 gallons of sorghum sirup produced annually is made in horse power mills having only the simplest facilities. In trying to lift the sorghum-sirup industry from its present depressed condition the first step should be to assist the tens of thousands of primitive sirup factories to make a general and considerable improvement in the quality of their sirup.

The processes described do not require expensive apparatus, dangerous chemicals, or expert skill. Probably most sirup makers, used to making sirup by merely boiling and skimming, will consider these processes too troublesome. But there are some who desire to make superior sirup which will please the consumer and the maker, and which will be in greater demand at higher prices. The fact that sorghum sirup is now made by few and simple processes is evidence that the manufacture is unperfected. The tendency of all modern manufactures is toward increasingly complex methods and a better product. The manufacture of golden sirup, and also of glucose sirup, has as many as ten processes. It seems to pay to use as many as improve the sirup.

Many processes in sirup manufacture were tested first in a laboratory way, using juice from a hand-mill. The successful processes were again tested in a larger way, using juice from a horse mill. The processes recommended here have been repeatedly verified, using all grades of sorghum juice.

Any sirup maker who may try the processes described here, even with only a panful of juice over a cook stove, settling in a clear glass bottle, so as to see the results, is asked to inform the writer of his conclusions.

SOIL AND CLIMATE AS AFFECTING QUALITY OF SIRUP.

Sorghum sirup is produced in forty-four States and Territories. Hundreds of samples of sirup have been collected from all parts of the country for comparison. So far as can be judged from numerous samples, the States which border on the Gulf, where the annual rainfall is 70 inches, often produce inferior sorghum sirup. The States of the plains, the semiarid section, where the annual rainfall is 20 to 30 inches, generally produce inferior sirup. The best sirup is produced where the growing seasons are more uniformly favorable, neither too wet nor too dry, and on soils of moderate fertility. A good growing season, followed by a moderately dry ripening season, seems best in any section. An even and proper supply of moisture appears to be much more important than the nature of the soil. In a very dry season rich and moist lowlands often produce the best sirup. In a wet season arid and poor uplands often produce the best sirup. It is probably true that almost any soil, in any section of the country, with suitable rainfall, can produce good sirup. And it is probably also true that by separating well the colorless solution of crystallizable sugar and of uncrystallizable sugar, which sorghum juice always contains, from the vegetable impurities, good sorghum sirup can be made in any section with cane from any soil. Canes of quick growth usually produce good sirup; for, to ripen unusually soon, the entire growing season must be unusually favorable, producing naturally pure juice, and thus, naturally pure sirup. Unfitness of sorghum juice for sirup making increases as canes become ripe or overripe. For these reasons sirup made in the far North is usually of better color, of milder flavor, and more palatable than sirup made in the South. Nebraska, Kansas, Oklahoma, and the part of Texas south of these States, produce the largest acreage of sorghum and the cheapest cane; the canes produce denser, richer juice, but often less pure, and consequently inferior sirup to that of States less subject to extremes of drought and flood. In Kansas the amount of true sirup-making material, the sum of the crystallizable and of the uncrystallizable sugar, varies less from year to year than the yield of wheat or of corn. The juice usually contains quite as much of these two sirup-making materials as Louisiana sugar-cane juice, yet it often produces sirup of poor quality, because it is often loaded with slimy and suspended impurities, which are not well separated from the juice by the process of sirup making now in use. The climate and the nature of sorghum can not be changed. Western sirup makers need to take more pains to grow good cane and to use better methods for cleaning the juice from its impurities. The generally inferior quality of Kansas sirup is not caused by the soil, for in favorable seasons it produces as good sirup as any section. It is not due to the lack of good sirup-making material in the juice, but to the excess of impurities present. When the juice is well purified it always gives good sirup. The special object of this bulletin is to show how the vegetable impurities which give sorghum sirup its dark color, rank flavor, and turbid appearance may be removed, so that better sirup may be always produced in any section or locality.

*From Farmers' Bulletin No. 135, Department of Agriculture Washington, D. C.

VARIETIES OF SORGHUM SUITED TO DIFFERENT LOCALITIES.

Sorghum has been cultivated in this country for fifty years, yet no general selection of the best varieties for sirup making has been made. Extensive correspondence with sirup makers in all sections shows no general preference for any variety except Early Amber for early maturing cane. In Kansas the most frequent preference is for the varieties which produce the most seed; for sorghum seed is a valuable product. The fact that sorghum has been grown long and extensively with very little selection of varieties has not been due to lack of intelligence on the part of sirup makers, but to the variable amount from year to year of the impurities in the juice of all the varieties. A variety may be selected in one season because it produces good sirup; it may be rejected the next season because it produces poor sirup. Planted early it may produce good sirup, and when planted late it may produce poor sirup in the same season and on the same soil, yet in both seasons it may produce ample and good sirup-making material. The impurities vary in amount, according as the growing seasons are favorable or unfavorable. If the impurities are not well removed from the juice, a part remains mixed in the sirup, and so if the juice is naturally pure the sirup is pure; if the juice is impure the sirup is inferior. This variable quality of sorghum sirup will continue until sirup makers remove the impurity which causes the variations. If two samples of good wine are to be compared, to one of which impurity like that in sorghum juice has been added, then the two samples can not be rightly compared until the impurity has been well removed. The same is true of two samples of sirup from two varieties of sorghum. When both samples have been refined, so that they are equally pure, then selection can be made of the best variety, and then the excessively variable quality of sorghum sirup from year to year will be largely done away with. Removal of all the impurities from the juices of 100 varieties of sorghum would show the true quality of each, and would surely lead to the selection of a few varieties superior in flavor or other quality.

For eight years careful search was made among hundreds of varieties of sorghum for a variety which would usually give as pure juice as that from sugar cane. Such a variety has not been found. In the past three years the effort has been made to find ways of separating the excess of impurity from sorghum juice, so as to make it as pure as sugar-cane juice naturally is. There is much promise in this line of work. When that is accomplished, selection of superior varieties can be made. At present no one can rightly name the best varieties for any section or locality, except Early Amber for early maturing cane.

But three varieties are recommended here: Early Amber (Fig. 1), the best early variety; Collier, the richest in sugar, and Colman, which produces good juice, larger, shorter canes, and more seed than the others.

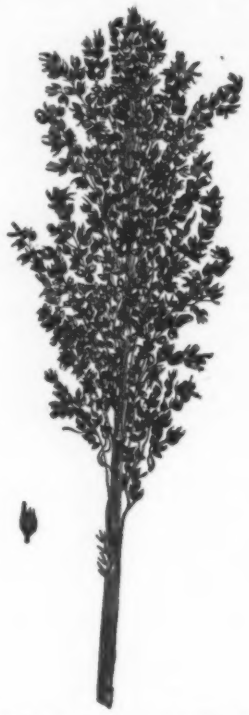

FIG. 1.—SEED HEADS OF EARLY AMBER SORGHUM.

FIG. 2.—HEAVY THREE-ROLL, VERTICAL, HORSE POWER CANE MILL.

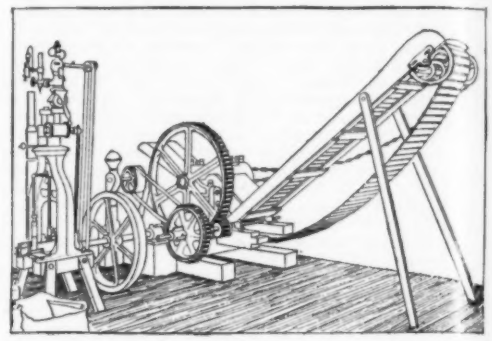

FIG. 3.—A SMALL STEAM CANE MILL, WITH VERTICAL ENGINE AND CARRIER FOR CRUSHED CANE.

PLANTING, CULTIVATING, AND HARVESTING.

Securing good, unmixed seed, of a good variety, is the first step toward making good sirup. A sirup maker should select typical canes of the varieties he prefers and put them in shock. The seed keep well there, unless taken by birds or stock, and should remain until they can be attended to. When quite dry, a dozen or more of the seed heads should be put into a stout grain bag. Pounding the heads with a club quickly thrashes the seeds. The seeds may be cleaned in the wind by pouring them from one pan into another, then shaking the pan to bring stems and trash to the surface, so that they can be removed. A sirup maker may thus obtain unmixed seed of a good variety, sounder, cleaner, and better than he can buy.

FIG. 4.—A "FARMERS' FEED COOKER," FOR HEATING JUICE BY INJECTION OF STEAM.

Planting and Cultivating.—A pound and a half of sound seed is enough to plant an acre. A bushel weighs 56 pounds. Some varieties ripen in three months, some in four months. When harvested, canes of mixed varieties are green, ripe, or overripe—all are not in best condition for sirup making. Some varieties grow tall, some short. In topping the bundles of cane the seed heads are often left upon the short canes, causing loss of seed, and the seeds which go through the mill injure the sirup. It is therefore better to plant pure seed.

In times of drought canes planted thickly suffer

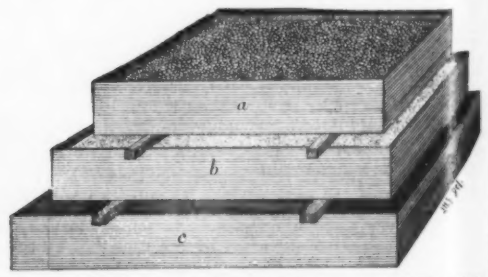

FIG. 5.—A GRAVEL OR PEBBLE FILTER AND SAND FILTER OVER A JUICE TANK.

more and give less pure juice. In the West most sirup makers plant too thickly. One cane in 6 inches of the row is quite enough, and with good seed one seed in each 3 or 4 inches of the row is sufficient. The planting and cultivating are often carelessly done. Cane and sugar-beet planters take vastly more pains in cultural work than sorghum growers. More care in planting and cultivating sorghum would often give a much larger yield of cane and better juice, all other expense being the same. Often much of the cane

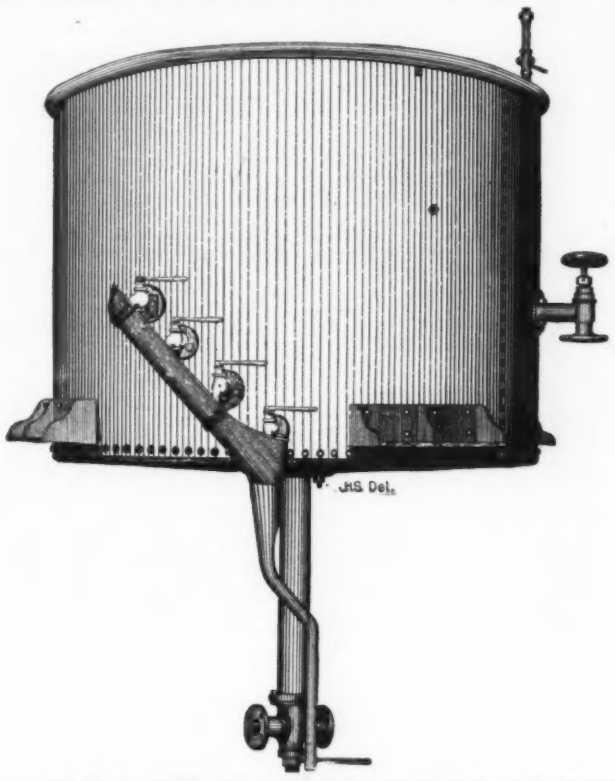

FIG. 6.—OUTSIDE VIEW OF A STEAM REHEATER AND SETTLER.

brought to Western sirup mills is more fit for fodder than for sirup manufacture. Some farmers who use the disk cultivator assert that its use is almost indispensable in growing cane; for very small plants can be cultivated with it, close to the row, without covering them, as ordinary cultivators do. It is easier and better to cultivate cane at the right times, keeping ahead of weeds. It is a German saying that sugar is made in the field. This is true also of sirup.

Harvesting.—Cane is often harvested at some convenient time, often when too green or overripe. It should be cut when in best condition for sirup. Topping the seed heads is often badly done, leaving much seed to go through the mill and into the juice. Good dyes can be made from sorghum-seed hulls, and starch from the seeds; hence the importance of keeping the juice as free as possible from these substances. The good canes only used to be stripped of leaves and brought to the sugar mill; now everything in the row—weeds, broken canes, suckers, etc.—are milled and serve to make sirup, since machine harvesters take all, and the mill grinds all. It is not economical to take excessive pains in manufacture, but it does pay to do work in a workmanlike manner—at the right time and in the right way.

GRINDING CANE.

There is a great loss of juice in grinding sorghum cane. The stalks are smaller and softer than sugar cane, yet the same mills and power extract less of the juice from sorghum. When the work to be done justifies the expense, it is better to get a first-class mill from first-class mill makers. It should be well set up. It is well to "anchor" each post with wire rope, as corner posts in wire fences are often anchored, to steady the mill against the twisting strain.

In the semiarid region, canes are often hard and woody, wilted and dried, and grind harder than fresh, juicy canes, causing greater loss of juice. A mill should give 60 per cent of the weight of the cane in juice; that is, 1,200 pounds of juice from 2,000 pounds of cane. A small horse mill can give as good extraction of juice as a massive mill driven by a powerful engine. Even a hand mill can give an average extraction of 60 per cent. Many sorghum mills give less. With as good extraction of juice as is got from sugar cane or sugar beets a ton of sorghum cane of average quality yields 20 gallons of sirup; but this can not be secured with single mills. (See Figs. 2 and 3.)

CLARIFICATION.

Sugar-maple sap is one of the purest natural saccharine liquids. Sugar-cane juice is less pure and sorghum juice is much less so. Their sirups rank in this order. When these three sirups are refined, as sugar refiners refine golden sirup, they have like qualities and equal values. The maple sirup loses its peculiar flavor, the sugar-cane sirup loses some of its impurities and its characteristic qualities, and sorghum sirup loses the excess of impurity which makes it inferior. Sugar-cane juice has about 1½ per cent of solid matter not saccharine. Sorghum juice has much more. The amount of crystallizable and uncrystallizable sugar is not usually less in sorghum juice. The mineral matter differs in no essential respect. The essential difference, so far as sirup making is concerned, is in the amount of vegetable impurity.

Unmixed sugar-cane sirup sells now at a higher price and is in much greater demand than sorghum sirup in all wholesale markets. This will be the case wholesale markets at a much wider range of prices than sugar-cane sirup. When the impurity remaining in finished sorghum sirup is removed it tastes like sorghum scum, and is due to scum which was not removed. When none of the impurities are removed from sorghum juice the sirup is objectionable; when well removed the sirup is good; when perfectly removed the sirup is first-class, and as good as any cane sirup. A part of the impurity can be removed from sorghum juice by clarifying the raw juice before heating to the boiling point; a part by clarifying the hot juice; a part by skimming; a part by clarifying the semi-sirup, and, finally, by purifying the finished sirup.

Progressive Clarification.—Sorghum juice can not be clarified well by a single process. If all the impurities which separate in the treatment of the thin juice are removed, more solid impurity is thrown out of solution by concentration to thin semi-sirup of 20 deg. density.* If this impurity is removed, more impurity is thrown out of solution by concentration to heavy semi-sirup of 30 deg. density, and a small amount of impurity is separated by the final concentration of the sirup to 36 deg. density, hot—that of finished sirup. It follows from this fact that there must be several clarifications—first, of the raw juice, then of the hot juice, then of the semi-sirup at 25 deg. density—in order to remove the impurities from the liquid. If not removed from the boiling liquid these solid impurities blacken and burn upon the heating surface and injure the color and flavor of the sirup. To make good sirup it is advisable to skim continuously during concentration. It is also necessary to remove from the thin juice and from the semi-sirup impurities which can not be removed by skimming alone. Good sirup can be made by skimming and settling the hot, thin juice and then skimming and settling the semi-sirup.

It is an advantage to skim and settle, then filter, the hot, thin juice, and, after concentration, to skim and settle, then filter, the semi-sirup. But a small sirup factory can make good sirup by simply skimming and settling the hot, thin juice and by skimming and settling the semi-sirup to 25 deg. density.

Clarifying Raw Juice before Heating to Boiling.—Mill juice contains a great excess of solid matter. These solid particles and slimes often settle upon the heating surface of the pan and discolor the juice in the first heating.

While the juice is heating, before boiling, there is no active circulation in it, and solid impurities often become colored by the intensely heated surface at the bottom of the pan. Emptying the pan sometimes shows that the hot iron is covered with slime. Even in the finishing end of the pan, while boiling well, moving a scraper over the bottom under the sirup sometimes brings up a gummy matter which had settled upon the heating surface. These are extreme cases, yet almost always the solid matter in sorghum juice is browned more or less by roasting upon the heating surface. This gives the sirup bad color and flavor. The remedy is to clean the juice from solid matter before heating, or to warm it so that it will settle well out of contact with very hot surfaces. A 20 per cent solution of sugar and of uncrystallizable sugar can be boiled three hours at 215 to 221 deg. F. with little change of color. Well-cleaned sorghum juice can be boiled three hours without objectionable change of color. In these cases there is no solid impurity to be scorched on the heating surface.

Methods of Clearing.—The method of clearing cold, raw juice, before heating, by claying and settling, was fully described in Farmers' Bulletin No. 90. The writer clarified 50,000 gallons of raw mill juice, in experimental work, by that process successfully. But it requires the use of heavy, coarse-grained clay, which is often not easily obtainable in some sections. It requires two hours for a small mill to grind enough juice to begin settling and two hours more to clay, settle, and decant the juice, hence the evaporator is delayed four hours in starting. The process cleans the cold, raw mill juice well before heating, but it is troublesome when fine-grained clay, or coarse clay mixed with fine clay, is used. Those sirup-makers who use suitable clay like this process. The past season an effort has been made to obviate the difficulties of settling raw juice well before heating to boiling. Any clay, even fine river silt, settles well in hot juice and carries down the solid impurities. This process alone makes an improvement in sirup. But when heating the juice, before claying, it is often colored more or less by the heating surfaces. A water bath, which may consist of a wooden pan with sheet-iron bottom, inch boards for sides and ends, 8 feet long, 3 feet wide, and 8 inches deep, may serve for a water heater. Inside this pan a similar but smaller pan is floated on water, which is heated to the boiling point. Juice in the inner pan is quickly heated to about 160 deg. F. Sediment and slimes may settle upon the bottom of this juice heater, but do not blacken by the heat of

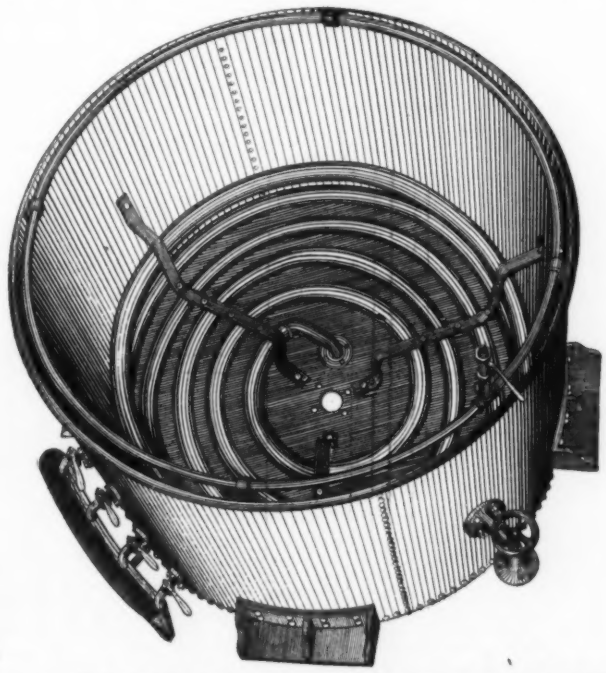

FIG. 7.—INSIDE VIEW OF A STEAM REHEATER AND SETTLER.

boiling water. When heated the juice can be drawn off in a tub or barrel by a siphon or by a large flat scoop, and can be clayed while hot, settled, and decanted. This water bath may have a furnace or may be heated by water boiled in the evaporator. A farmers' feed cooker (Fig. 4), which costs about $25, can be used for heating by blowing steam directly into a barrel filled with juice, or a wooden pan having a double

*This and following numbers expressing density refer to the Baumé scale: 20° B.=35.7 per cent total solids; 25° B.=45 per cent total solids; 30° B.=54.3 per cent and 36° B. =65.9 per cent total solids; 36° B. hot—that is, at the temperature of boiling water—would be equivalent to 40.5° B. at 63° F., at which temperature a gallon of sirup would weigh 11½ pounds.—H. W. W.

sheet-iron bottom, making a "steam jacket," may be employed for heating below the boiling point. Those who make sirup by steam can easily warm and settle clayed juice by a steam-jet pump. The writer's work has been done mainly by heating the raw juice to 160 deg. F., then claying, settling, and decanting the clear juice into the evaporator. It is the belief of the writer that less impurities are dissolved by heating to a low temperature than in settling them out, and also that this heating of raw juice should be continued no longer than necessary before settling, for the same reason. On drawing off the warmed juice from the heaters a surprising amount of slimy impurities is sometimes found settled upon the bottom, which partly explains the extremely variable quality of sorghum sirup when made in the usual way.

Processes.—Process No. 1.—For the smallest sirup factories. A little mill, a plain wooden pan with sheet-iron bottom, a juice barrel, and a half-barrel tub are sufficient.

Grind a barrel full of juice; let it settle as long as may be; draw off the juice from the upper part of the barrel, leaving the rest to settle longer, taking as little turbid juice as possible. Heat the settled juice in the pan to near boiling, skim, empty it into the tub, add clay, mix well with a hoe (the juice should look clayey), let it settle half an hour to an hour, and gently pour off the settled juice. In pouring off slowly, the juice is apt to run down the inside of the tub unless it has a tin strip tacked on, for a pouring lip. Run the clear juice back into the pan, boil, and skim until it begins to thicken, and when the sirup is about half done empty it again into the tub, add clay as before, mix well, cover the tub to retain the heat, and let stand over night. Next morning, while the mill is grinding the first barrel of juice, pour off the settled semi-sirup slowly and carefully, leaving all of the settlings in the tub. Return this clean semi-sirup to the pan and boil it to sirup. Place a sample of the sirup in a clear glass bottle in a strong light for comparison. Return the settlings remaining in the tub to the juice barrel, rejecting the solid settlings, to be clarified again.

Process No. 2.—The raw juice from the mill goes directly into a long, shallow settling pan. Two sheets of iron, each 8 feet long and 3 feet wide, are riveted together, end to end, forming one sheet 16 feet long. This is nailed on a wooden pan of the same size, forming the bottom of the pan. In nailing on the iron, at first nail far apart all around, then between the first nails; then divide and subdivide the spaces until nailed closely enough. This puts the bottom on smoothly, not taking all the stretch of the iron at one place. Also put a wooden partition lengthwise through the middle of the pan, leaving a passway for juice at one end. This forms a long, shallow pan, 6 or 12 inches deep, as required, and divided into two channels, each 1½ feet wide and 16 feet long. The juice enters at one end, flows gently down one channel through the passway, and back through the other channel to the end it entered, depositing impurities as it flows along. The settled juice is drawn off at the surface of the juice by a swing pipe, into the juice heater or pan, having traveled and settled in a trough 32 feet long. The juice should not be drawn off faster than needed, leaving it to settle as long as may be, the raw juice going into this settling pan all day and being drawn off when needed. The pan is thus a storage tank for juice and also a settling pan. It should be well washed each night. The decanted juice is now heated and treated as in process No. 1, giving a settling of cold, raw juice, a clayed settling of juice heated to boiling point, and a settling over night of the clayed semi-sirup at about 25 deg. density. The decanted semi-sirup is reduced to sirup.

Instead of settling raw juice in the long, shallow pan, it may be filtered first through a pebble filter, *a* (Fig. 5), then through a coarse sifted sand filter, *b*, and finally into the juice tank, *c*. The writer obtained a good filtration through several inches of coarse sand, the fine sand having been well sifted out, because it hinders and clogs the filter. But when juice is very slimy it is better to filter first through pebbles, sifted out of the sand filter; for the pebbles retain gummy foam, seeds, leaves, etc., and thus relieve the surface of the sand filter; or, better, the raw juice may be settled first in the long pan, then through coarse sifted

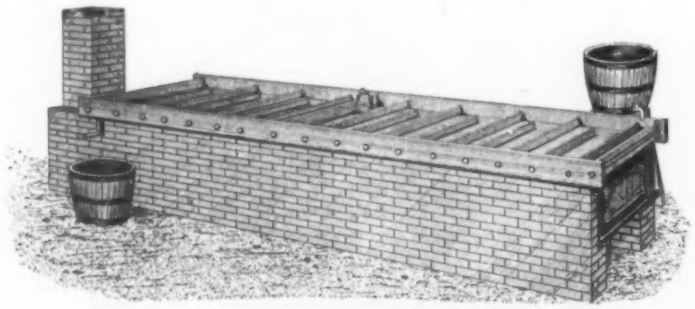

FIG. 8.—A FIRE EVAPORATOR.

sand. These filters should have sufficient surface to filter all the mill juice for half a day or for a day, or there should be two, so as to avoid interruption of work. After going through this cleaning, the juice is treated as in process No. 1. The best size grain for the sand filter seems to be about one-thirtieth of an inch; that is, thirty of the grains of sand, side by side, measure one inch. The filter boxes have cross slats, nailed a little way apart, allowing the juice to pass downward through the filtering material, in all parts of the filter, into a juice tank beneath. It is well to place wire-screen netting upon the cross slats, to better retain the sand, unless the latter is sufficiently coarse to be retained in place by the slats. The writer used closely woven gunny cloth, but prefers a perforated metal bottom. When clogged the sand can be washed and replaced in the filter.

Process No. 3.—Raw juice from the mill is warmed in the water bath, in the steam "blow up" (Fig. 4), or in the "steam jacket" pan, and is then drawn off and clayed, settled, and decanted, then treated as in process No. 2, being clayed and settled when heated to boiling point. The semi-sirup, at 25 deg. density, is clayed and settled overnight.

Process No. 4.—To the settled or filtered mill juice heated to nearly boiling point and skimmed, clariphos* is added at the rate of not more than 1 gallon to 2,000 gallons of juice; that is, 1 pint of the acid to 250 gallons of juice. Boil and skim the juice a few minutes, then carefully neutralize it with lime, a little lime added at intervals, until a piece of blue litmus paper dipped in the juice shows only a slight tinge of red. Care must be taken that the blue paper does not remain blue, which would show that too much lime, which causes the sirup to be a dark color, had been used. Also be careful that the paper when dipped in the juice does not become bright red, as this indicates that the juice is too acid; for sirup containing the free acid is never clear and is too acid to the taste. The

FIG. 9.—A SACCHAROMETER AND CUP.

juice is settled and decanted after liming, and the semi-sirup, at 25 deg. density, is clayed and settled, as before. The object in adding clariphos to the juice before liming it is to form phosphates with the mineral matter. This process is not difficult for those who can use lime accurately. It improves the sirup, but very good sirup can be made without it.

CLAYING JUICE AND SEMI-SIRUP.

Clay attaches itself to the solid impurities, weights them, and causes them to settle. Infusorial earth is preferred, but is not so readily obtained. Clay settles slowly in cold, raw juice; quickly and compactly in hot juice; slowly in semi-sirup of 25 deg. density; more slowly in heavy semi-sirup of 30 deg. density, and settles imperfectly in finished sirup. It is preferable to mix clay with limewater. More lime than water will dissolve would be better, but care must be taken not to use excess of lime in the clay, since it will spoil the sirup. Lime causes the particles of clay to flocculate—that is, to adhere together, and thus settle better; it also reduces the acidity of the juice in proportion to the amount used. Clay may be added to juice or semi-sirup until the density of the clayed liquid is about 2 degrees higher by the saccharometer than it was before claying. More clay does no harm. It should be well mixed in the hot liquid. If the clay is lumpy, it is advisable to wet it several days before using to allow quicker mixing. It is to be wished that some heavier substance than clay could be found which would settle well and compactly in semi-sirup at 30 deg. density. It seems best to settle semi-sirup with clay at about 25 deg. density, rather less than more.

LIMING JUICE.

The acids naturally in sorghum juice often make the sirup unpleasantly acid. The market is now favorable to neutral sirups. Acids also dissolve impurities and keep them in solution, so they cannot be removed by skimming, settling, or filtering. Neutralizing the acids in the juice throws the dissolved impurities out of solution so that they can be removed.

REHEATING.

When a semi-sirup refuses to settle clear, the most effective way of brightening it is to reheat and resettle it. This often makes surprising improvement, and testing the sediment which results from impurities, which would neither rise nor settle, shows that it pays to clean semi-sirup well. The drainage from scums, the liquid part of settlings, and the sweet washings of tanks and pans are reheated and filter-pressed or resettled in good sugar-factory practice. Figs. 6 and 7 show a steam reheater and resettler used in many sugar factories. The scum, etc., are heated to nearly boiling, settled several hours in this reheater, then drawn off by the side valves below the scum and above the sediment until the two are nearly together, and the refuse is then washed out.

Acid juices should not be used with iron or galvanized vessels unless the latter be painted with an acid-proof paint. Wooden buckets are to be preferred to those made of iron for handling the juice.

FILTERING.

When a sample bottle of semi-sirup at 25 deg. density is placed in a strong light and another sample of the same semi-sirup, after claying, settling, and decanting, is placed beside it, the settled sample is seen to be better in color and clearer; it is also of better flavor. It still contains, however, small particles of suspended matter which settle very slowly, leaving the semi-sirup bright. Sugar refiners and many sugar makers place great stress upon filtering. Sorghum-sirup makers never filter. If filtering is done it must be between the clarified juice and semi-sirup of 27 deg. density. Refiners and sugar makers frequently use bag filters. A bag of twilled cotton, 6 feet long and 2 or 3 feet wide, is folded twice lengthwise and slipped into a strong, loosely-woven sheath, which keeps it in compact form. Many of these bags are placed in a hot chamber and are attached to the bottom of a tank containing the liquid to be filtered. The hot liquid filters through the bags.

SKIMMING.

There are three ways of removing solid impurities from sorghum juice—skimming, settling, and filtering. Each of these ways should be used. Skimming alone removes only a part of the impurity, which, entangled with bubbles of air or of vapor, rises to the surface. The rest of the impurities do not rise, but tend to settle. When the bubbles are broken by stirring or boiling in, the scum disappears and does not rise again. Sirup makers often skim very carefully, yet fail to remove the impurities which spoil the sirup. Better sirup can be made by settling only than by skimming only.

EVAPORATION.

A good evaporator which can be easily cleaned has an influence upon the quality of sirup. Sirup may have been recently emptied out of a pan; the pan may be clean in one sense, yet may not be in good condition to receive more juice, for the film of sirup (foam) and some sediment remaining have been dried until the heating surface is covered with a solid varnish. When cold juice again flows into this pan, this covering of dried molasses dissolves slowly, often burning upon the hot surface and coloring the sirup for several hours after being heated. It is not much trouble to sweep out the pan with a broom and a little water before refilling, or at least to see that the dry matter is redissolved in the fresh juice, to avoid burning.

A float valve, controlling the flow of juice into the pan, thus regulating the depth of liquor and preventing flooding or burning, is used by maple-sirup makers. It is recommended by sorghum-sirup makers who use it. A fire evaporator is shown in Fig. 8.

Use of Crushed Cane as Fuel.—In the West sun-dried crushed cane is often used as fuel. A sheet-iron funnel tapering toward the end nearest the furnace, so as to slightly compress this light fuel as it is pushed through into the furnace, and having a sheet-iron door hinged to the upper surface, is a safer and better method of firing than to push the crushed canes directly upon the fire. A forkful of the fuel pushes the door inward, and the door closes itself when the work is withdrawn. In all sugar-cane producing countries the crushed canes are now carried from the mill by an automatic carrier to a special furnace, where they produce nearly or quite sufficient fuel for the factory.

The Saccharometer.—A saccharometer (Fig. 9) is an instrument for showing the density of saccharine liquids. The Baumé instrument is the one referred to in this bulletin. When placed in a tin cup filled with the liquid it floats higher or lower, according to the density of the liquid. Sorghum juice usually shows from 8 to 10 deg. density; thin semi-sirup is 20 deg. density, heavy semi-sirup is 30 deg., hot finished sirup is 36 deg. to 38 deg., and cold sirup is about 40 deg. density. If it is found that clayed semi-sirup at 27 deg. density settles slowly and imperfectly, the semi-sirup should be settled at a lower density, say 22 deg. to 25 deg. More impurity would be thrown out of solution by boiling semi-sirup to 27 deg. or 30 deg. density, and so more impurity would be removed by boiling and settling at 27 deg. to 30 deg. density. But it is usually better to settle the semi-sirup at not more than 25 deg. density. The use of a saccharometer is not essential in conducting the work, but it is a help. The test cup ordinarily used with the saccharometer can be made by a tinner. The writer prefers one not larger than necessary, about 1¼ inches in diameter and 9 or 10 inches deep, having a handle, and a shallow pan serving as a foot stand and also receiving the overflow of the sirup when the saccharometer is dropped in. In ordering a saccharometer always specify a Baumé instrument, for this scale is almost universally used by sirup makers. The saccharometer is made of glass, is thin and fragile, and is for use in hot or cold liquids. These instruments are also termed "hydrometers" or "spindles." In testing juice fresh from the mill let it stand a while to allow bubbles of air to escape, otherwise the density, as indicated by the saccharometer, will be less than it should be.

SETTLING.

Cold raw juice settles very slowly and imperfectly. Clayed cold raw juice settles better, but takes some time. The settling of hot, clayed juice is rapid, and the settlings are not bulky or wasteful. The settling of hot-clayed semi-sirup varies in the time it requires, according to the density, the liming of the juice, and the temperature of the air and the size of the grain of the clay. Sirup when cooled settles slowly. When

* Acid phosphate of lime.

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semi-sirup is clayed it is well to cover the barrel to retain the heat longer. Some sugar factories which settle all the semi-sirup keep the settling tanks in a hot room, and settle from six to ten hours. It is advisable to give semi-sirup time enough to thoroughly settle: from twelve to twenty-four hours are usually sufficient. It will not ferment in even a much longer time. It is not best to draw off the settled semi-sirup too closely to the settlings. Usually four-fifths of the semi-sirup can be safely decanted; the rest can than be decanted into another vessel, leaving the sediment, which may be put back into the raw-juice tank to be reclarified; or, as is the custom in sugar factories, the bottoms from several tanks may be put together, reheated, and resettled. Sorghum semi-sirup will settle without claying, but claying gives better settling and cleaner semi-sirup. Settling warmed raw clayed juice, or clayed hot juice, or clayed hot semi-sirup, at 25 deg. density, makes much improvement in the quality of the sirup. The settling removes solid matter from raw juice before heating to boiling, solid matter coagulated by heating and solid matter precipitated during evaporation to 25 deg. density. As the juice has been skimmed as usual, the impurity removed by these settlings is such as cannot be removed by skimming.

FILTERING AND COOLING FINISHED SIRUP.

Sirup made by the processes described is when first finished apparently clean, of good color, and has little sorghum flavor. It is not bright or transparent; for it still contains a small amount of impurity which was thrown out of solution during concentration of the semi-sirup from 25 deg. density to 40 deg. density, cold. If the juice could be limed to full neutrality it would throw out less impurity during the final concentration. When the sirup is first finished the small particles of impurity are invisible. But if a bottle be filled with the fresh sirup and placed in a window it will be seen that in a week or more these invisible particles adhere together, forming larger particles, which very slowly settle in the cold finished sirup, leaving the sirup very clear and bright. Singularly, this final settling of the finished sirup seems not to occur in this product from juice that is not limed, although such sirup has more sorghum flavor and contains more impurity.

It is very desirable to remove from finished sirup all of the solid impurities it may contain. A sirup filter and cooler combined for small factories may consist of a wooden box 14 inches or more deep, 8 feet long, 3 feet wide, the bottom of sheet iron, well painted. A false bottom of slats, a little apart, or of perforated boards, is placed about 2 inches above the bottom of the box. Its object is to leave the drainage chamber at the bottom, so that the sirup may drain downward from all parts of the box. Upon the false bottom is placed excelsior (wood straw), used in packing goods. It has been recommended to boil the excelsior in a solution of caustic soda before using it, or to soak it well, first in cold water, changing the water, then in hot water. The writer merely soaked the excelsior in a barrel of cold water two or three days, changing the water as often as it showed color or flavor. The object of this is to remove the extractable matter from the excelsior, which would give color and flavor to the sirup. The excelsior can often be had from merchants for the asking, or can be ordered by the bale. The washed excelsior is placed upon the false bottom in the box, a little at a time, closely but not tightly packed, leaving no large open spaces through which the sirup may flow. It is well to place the fibers crosswise to one another, instead of parallel. The box is thus nearly filled with the excelsior. A loosely woven gunny cloth, larger than the box, is placed over the top and hangs down over the sides and ends of the box. This is to strain the hot, finished sirup, removing the gummy foam before it reaches the excelsior. The loosely woven gunny cloth cover can be washed and replaced as often as may be necessary. A molasses gate, or a plug, is placed near the bottom of the box for drawing the finished sirup from the drainage chamber below the filter. When the filtering material is clogged in one place the sirup flows down through another part of the filter. This filter box should be always kept nearly full of sirup. The sirup should not be drawn off sooner than necessary. It should be allowed to stand upon the excelsior as long as may be.

If sirup is simply run through the empty filter it will do little good. By standing upon the excelsior the impurities adhere to the wood fiber. By slowly drawing off the filtered sirup the impurities are not carried along with the sirup. It is well to place an empty barrel under the outlet pipe and let the filtered sirup slowly run into it, taking care it does not overflow, meantime running sirup into the filter box, keeping it full. The finished sirup going into this filter should be warm as may be. If much very hot sirup is to be filtered it would be well to cool it a little before it stands in the filter. This filter answers the same purpose as when wine and cider makers and brewers let turbid liquids stand a day or two in a tank filled with clean wood shavings, and then slowly draw off the brightened liquid, the gummy matter adhering to the shavings.

It is said that when the excelsior is clipped into short pieces, like needles, an inch or two long, it packs much more easily in the filter than the long excelsior, leaving fewer open channels for the sirup to flow down, and also being less compact. When the filter has become clogged the excelsior should be drained, then washed in a little water. This sweet water should be put in the raw-juice tank, and the excelsior should be well washed and replaced. The length of time the filter will act before clogging depends upon the care which is taken in cleaning the semi-sirup.

The writer successfully filtered hot, finished sirup through very coarse sifted sand. It is hoped that further experimental work will develop this plan of cleaning finished sirup as the last step in the manufacture. Some European sugar experts assert that sirup of 36 deg. density, hot, can be filtered well through a bed of pure sifted sand with grain of suitable size. River sand usually contains clay, fragments of soft shale, soapstone, etc., which unfits it for this purpose. Pure quartz sand, ready sifted to proper size of grain, costs little.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Minerals in Persia.—From a reliable source I have just received an interesting account of the undeveloped treasures in Persian soil. There are numerous large petroleum fields, not one of which is worked to any extent, much less in a systematic way. The petroleum fields in the Provinces of Mazanderan, Gilan, Chamsee, Kerman, Luristan, and Arabistan are hardly touched, and render no profits worth mentioning. In those mountainous regions naphtha is also said to exist in considerable quantities. Experts on this subject believe that the two cities Sohab and Schuschter would serve best as central stations from which to work the fields. Sohab can be easily connected with the Dijalah River by means of a navigable canal, by a narrow-gage railway, or by pipe lines, so that the oil could be conveyed via the Dijalah and Tigris Rivers to Mohammere, without heavy freights. From there it would have to be transported by special vessels to India, Egypt, China, and Europe. The natural transportation route from Schuschter is along the course of the River Karun. The environs of Schuschter are particularly rich in petroleum and naphtha.

At present nearly all the petroleum consumed in Asia and Africa (particularly in Japan, China, India, and Egypt) is furnished by the wells of Baku and Pennsylvania. Persian petroleum, with less costs for freight, could doubtless compete successfully in nearby countries.

The rich Persian coal veins are not properly appreciated. They cover wide regions and are worked in a very primitive way. There can be no doubt that if vertical and horizontal shafts were driven into the veins and the water pumped out, quantities of good coal could be brought to the surface.

The Persians dig unsupported shafts, not more than 20 or 30 feet deep, and abandon them as soon as water makes the work difficult, reopening the vein at another spot. Only the surface coal is utilized.

Copper, argentiferous lead, iron ore, arsenic, sulphur, cobalt, antimony, borax, tin, and other minerals are also found in large quantities in the Persian mountain districts. All these resources must remain undeveloped so long as Persia possesses no transportation facilities.

Even the well-known turquoise pits of Persia, the most important of which are those of Nishapur, in the Province of Khorassan, yield so far very little good material, owing to the fact that they are owned by natives, who cannot work them in the modern way.—Oliver J. D. Hughes, Consul-General at Coburg.

The Yangtze Floods.—Under date of Shanghai, July 25, 1901, Consul-General Goodnow reports that the most disastrous floods are prevailing in the valley of the Yangtze River. He understands that they are the worst known by Europeans in that valley. All the towns in the neighborhood of Wuhu and Kiukiang are to a large extent under water. The farms, especially in the rice-growing region about Wuhu, are so completely flooded that there is no hope for the crop this year. In addition to this, thousands of people have been drowned and unknown numbers rendered homeless by the overflow. The stoppage of trade is very serious. Not only is the local trade paralyzed where the flood exists, but the river is so far beyond its banks that navigation is difficult and dangerous. It is reported that five large river steamers plying between Shanghai and Hankau are out in the fields in different places. The destruction of the crops in vast regions, and particularly the probable destruction of the rice crop in the region of Wuhu—the great rice-exporting center—will probably add famine in the Yangtze Valley to the other difficulties besetting the Empire.

American Sewing Machines in Eastern Turkey.—The American sewing machine has been recently introduced into this consular district with signal success. It completely monopolizes the market, which hitherto has been occupied by machines of English or German make. The lightness, uniform excellence, adaptability to a variety of operations and low price have been promptly appreciated in this region; and all those who own the clumsier European make, when able to afford it have replaced their machines by those of American manufacture.

Fifteen months ago, the agent of one of our leading sewing machine companies* settled at Mezreh. Since the opening of his agency he has sold three hundred machines—one-half in the twin cities of Harput and Mezreh, the remainder in the other towns and cities of this consular district. Sales have increased so rapidly that he confidently looks forward to doubling the business during the coming year. It is not a common thing in oriental countries to see a market so completely conquered in so short a time.

The success attending this attempt is such that American manufacturers desirous of securing a satisfactory foothold for their wares in the Orient may profitably note the methods employed by the company in question.

In the first place, the machines have a well-earned reputation at home and abroad. In the next place, an active, intelligent agent is located here, whose whole time is devoted to pushing this one article. He conducts his propaganda much as an American drummer would, and is the antithesis of the typical Oriental shopkeeper, smoking his nargileh while awaiting customers. A female employé is in attendance to give the necessary instruction. The agent carries on his operations throughout the two vilayets comprising this consular district, Mamouret-ul-Aziz and Diarbekir. Rent, salaries and traveling expenses are so low in this region that but a small margin is needed to cover these items.

The immediate success following this enterprise leads me to the conclusion that it is highly desirable for firms seeking to gain promptly a strong foothold in this region to send capable native agents, whose remuneration will depend largely on the amount of their sales, and whose efforts will be devoted exclusively to a single article, or to a small group of allied articles.—Thomas H. Norton, Consul at Harput.

* The Singer Company.

New Fuel for Swedish Railroads.—Sweden imports yearly large quantities of coal and coke, and this trade is increasing steadily, in pace with the industrial activity and the building of new railroads. Several millions of dollars are annually paid out to foreign countries for fuel. This has caused the authorities to consider whether Sweden could be made more independent in this respect. It has been suggested that the State railroads could get their motive power partly from waterfalls, and experiments will probably be made in this line.

The managers of the State railroads have been instructed to make trials of peat, peat charcoal, and peat briquettes as fuel for locomotives. The intention is to construct a special locomotive to be used in these experiments, and if they are successful other engines will undoubtedly be built, because peat is abundant in this country.

The navy and the State railroads have also tried to use Swedish coal, but without much success; the efforts will be continued, however. A Gothenburg newspaper reports to-day as follows:

"In the new briquette factory at Elmhult, belonging to the State, experiments will be made this fall in the production of a cheap and practical fuel for Swedish railroads. In locomotive furnaces, Swedish coal cannot be used alone, because it contains too much scrap and incombustible substances, which are not consumed, but form offal and ashes. It must, therefore, be mixed with English coal, but this is becoming more and more expensive. The possibility of using Swedish coal alone is, therefore, ideal, and the above-mentioned factory has been built to be employed in the attempts to make or refine Swedish coal into a good fuel. The factory will operate according to a German patented method, and has been put up under the supervision of a German. It will be started this fall, and the work will continue night and day. It is calculated that the output will be 36 briquettes per minute—that is, 51,840 per 24 hours, or 15 carloads of 10,000 kilogrammes per car. Experiments will first be made with 40 carloads of Swedish coal of the lowest grade."—Robert S. S. Bergh, Consul at Gothenburg.

Opening for Chemical Fire Engines in Haiti.—Minister Powell writes from Port au Prince, September 11, 1901, to call the attention of United States manufacturers of chemical fire engines to the market in Haiti. He says:

In this capital, as well as in all of the principal cities of the republic, the houses are chiefly constructed of wood, which in this climate soon become like tinder, needing but a match to start a large and destructive conflagration that sometimes sweeps half the city before the flames are mastered. The cities have some good engines, but on account of the limited supply of water they are practically useless. The loss from fire is so great—ranging from $50,000 to $100,000—that insurance companies have refused to accept risks anywhere in the republic. I will be glad to aid our manufacturers in any way, by calling the attention of the government to the benefits to be derived from chemical fire engines.

New Steam Generator in France.—There is a tendency among constructors to increase steam-boiler pressure, in order to allow the use of smaller cylinders. French locomotive boilers already carry from 16 to 18 kilogrammes (35 to 39 pounds) ordinarily.

My attention has been attracted to a company that is being formed with the object of manufacturing and introducing a new steam generator, which will insure a pressure variable from 20 to 80 kilogrammes (44 to 176 pounds).

This powerful generator, constructed by M. Serpollet, is made of cast steel, fused at 1,800 deg. C. Within, it is an arrangement of non-capillary tubes, and it is in these that the instantaneous vaporization is effected without danger of escape, up to a pressure of 80 kilogrammes (176 pounds). The apparatus placed in the fire box constitutes a sort of blower, allowing great facility to the fire draft. On account of its heavy construction, it offers ample resistance to the pressure.

It is claimed that it is not affected by immediate contact with the fire, and that capillary action is completely suppressed.

By this apparatus, an absolutely new departure is brought about in the generating of steam, and it is contended that its application will be of incalculable value, either as a motor agent or in the employment of steam dried at hitherto unknown temperatures.

Either coal, coke, or petroleum may be used for fuel.—Hilary S. Brunot, Consul at St. Etienne.

American Coal for Germany.—Consul Kehl writes from Stettin, September 29, 1901, that the James Stevensen Aktien Gesellschaft, of Stettin, is interested in American coals, including anthracite, and has sent a representative to the United States with a view of opening up business relations. The Stevensen Company, he adds, is one of the largest fuel dealers in that section of Germany, importing nearly 250,000 tons per year from Great Britain.

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The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Cochineal Cultures in Mexico.—The agricultural expert of the German Embassy at Buenos Ayres, who visited the vanilla and cochineal cultures in Vera Cruz, reports as follows on the latter:

If a retrogression is apparent in the vanilla culture in Mexico, same is still more considerable in the cochineal production of this country. And yet it constituted in former years the wealth of the State of Oaxaca and a not inconsiderable portion of the wealth of all Mexico, inasmuch as no less than 2,400,000 pesos worth of cochineal or "grana," as it is called in its marketable state, was exported from Mexico at the time of Humboldt, when the total export amounted to 22,000,000 pesos. The introduction of this culture on the Canadian islands, and especially, later on, the invention of the aniline colors, have almost entirely destroyed it. At present the only cochineal produced is in the districts of Ocotlan and Ejutla, which is mostly used in the country itself for dyeing. Still, it is very interesting to visit one of these "insect gardens" and become acquainted with their culture. It is only conducted by small farmers, Indians or Mestizos, in small gardens adjoining their houses. The very small ones among them are mostly only engaged with raising the brood, which they sell to the larger farmers at 50 cents per pound, if the latter have not raised enough themselves. It seems that for this purpose a different cactus variety bearing less prickles is employed than is used for breeding the insects for the production of cochineal proper. The said variety is also planted closer together. In order to protect the leaves from being rinsed off by rain, these cactus plants, which are about a meter in height, are covered with a dense roof of corn leaves or grass. The fructified females raised there are then placed in somewhat larger gardens on cactus plants above which for protection a high structure has been erected with leaves and straw, allowing a man to comfortably pass underneath. The setting out of the females is done in "tenatillos," small braid works of palm leaves, which are attached to the cactus by means of cactus or agave prickles. When the young emanate from the womb, they soon also leave the tenatillos, which are provided with an opening, and quickly spread over the neighboring portions. The mother insects freed from their young soon die off and their hollow bellies furnish the so-called "saccadilla" or black cochineal, which is placed on the market separately. In three months the young insects, which have gradually covered the whole surface of the cactus plants with their white down, have become ripe. They are now swept off and killed either by suffocation in piles, by heating on iron plates or—which method seems most common—by immersion in boiling water, and then dried in the sun. The cactus stocks which have once been inhabited are cut down, since they cannot be used a second time. This seems peculiar, as they do not appear to have lost any of their nutritive substance through the insects and do not exhibit any injuries; the animals probably confine themselves to withdrawing by means of their fine trunk the sap from the stock piece of the cactus. The old cactus plants are, after removing the used stock pieces, twice made to sprout further stock pieces, on which the insects are set out. After three years, however, they are destroyed entirely and new plants are raised by setting out stock pieces, which are fit for use only after two to three years. Only in case the soil is plowed up and well manured are they fit for the reception of insects after one year.

The cochineal culture, in contradistinction to the vanilla culture, requires much detail work. The roofs must be taken off hourly, to admit the sun; the plants have to be freed from injurious insects, especially from a caterpillar which seems to eat up the cochineal insects, since upon being opened it is found to contain the same red liquid as the latter. Most work is occasioned by the shifting of the "tenatillos," which have to be stuck on a new stock piece almost daily, so that the little ones that creep out find sufficient room and food from the beginning. The gardens must also be preserved from chickens, for whom the well-fed insects form a highly-prized titbit. The work in these gardens is usually a family occupation, in which no outside workmen take part.—Lack und Farben Industrie.

New Process for the Production of Caseine Cement.—The caseine is made feebly alkaline by means of soda or potash lye and then subjected for about 24 hours to a temperature of 60 deg. C. Next follow the customary admixture, such as lime and water-glass, and finally, to accomplish a quicker resinification, substances containing tannin are added. For tannic admixtures to the partially disintegrated caseine, slight quantities—about 1 per cent—of gallic acid, cutch or quercitannic acid are employed. The feebly alkaline caseine cement containing tannic acid is used in the well-known manner for the gluing together of wood.—Neueste Erfindungen und Erfahrungen.

Opaque Window Panes.—A convenient method to make window panes opaque consists in painting them with a solution of—

Dextrin	200
Zinc vitriol	800
Bitter salt	300
In	
Water	2,000

—Pharmaceutische Zeitung, Berlin.

Durable Black Varnish for Iron Stoves.—Heat 1 kilo of wood tar to a boil and add with incessant stirring 1-16 kilo of powdered green vitriol. The portion of the stove to be varnished is heated and the hot varnish applied with the brush. On the heated surface the varnish dries quickly and a solid, lustrous coating is obtained.—Die Werkstatt.

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